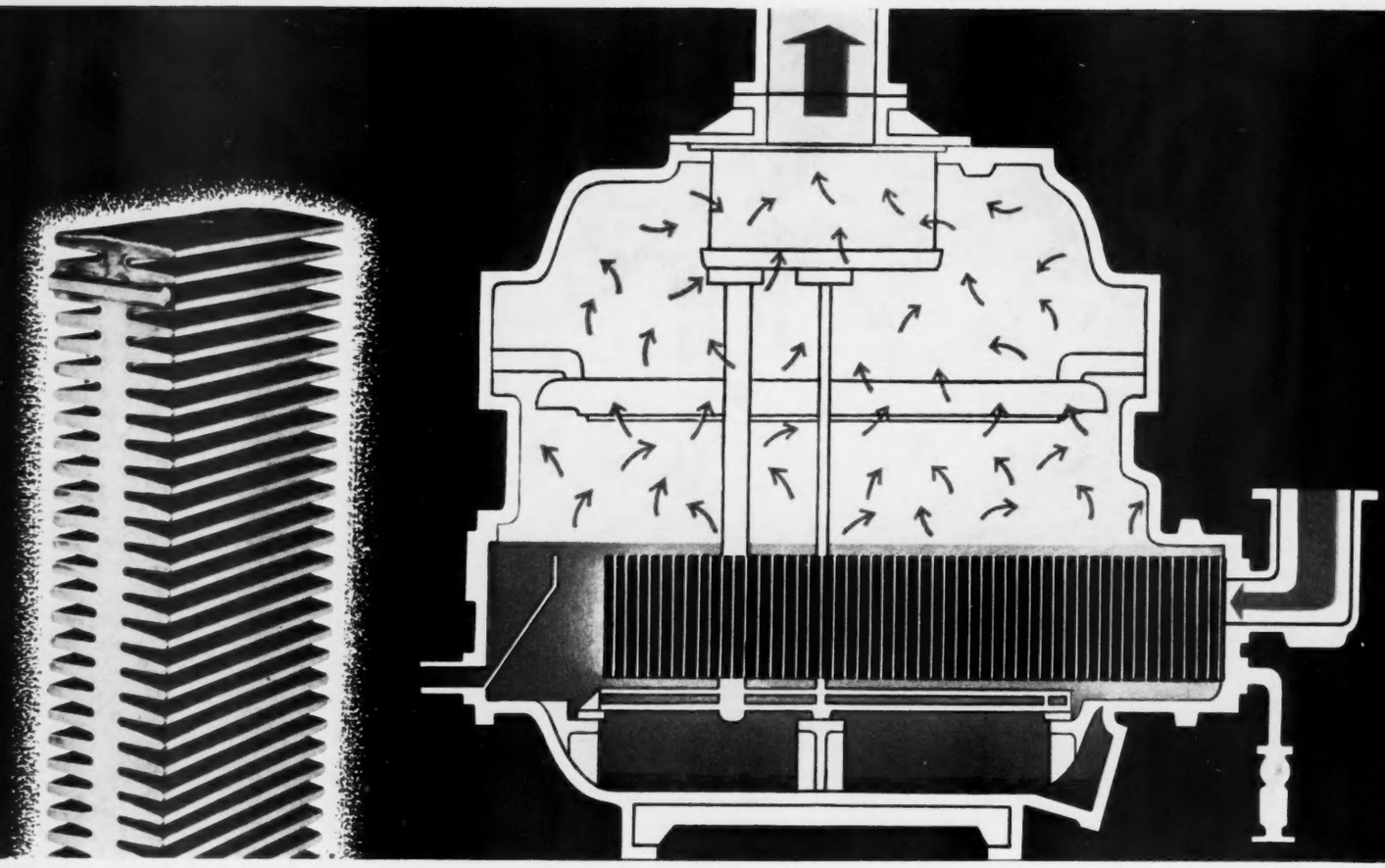
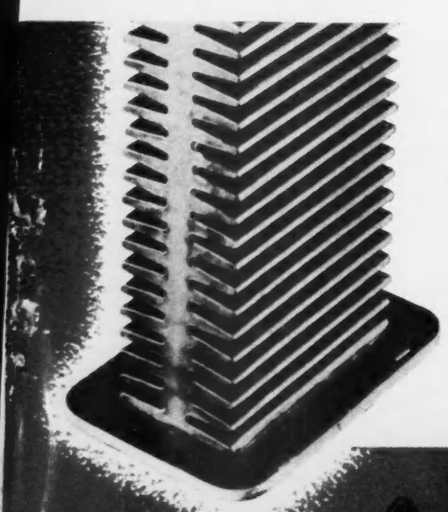
THE ENGINEER

MARCH 13, 1959 | 28 ESSEX STREET, STRAND, LONDON, W.C.2 | TWO SHILLINGS



TOP RIGHT. *A diagrammatic view of the unit. The element uses waste steam for heating, and flexes with variations of temperature to drop the scale to the base of the evaporator shell. Very lengthy periods of service can be completed before shut downs are necessary for raking out the scale.*

LEFT. *This new sea water evaporator element is fabricated from Monel sheet. Its special corrugated shape provides a large heating area in contact with the brine.*



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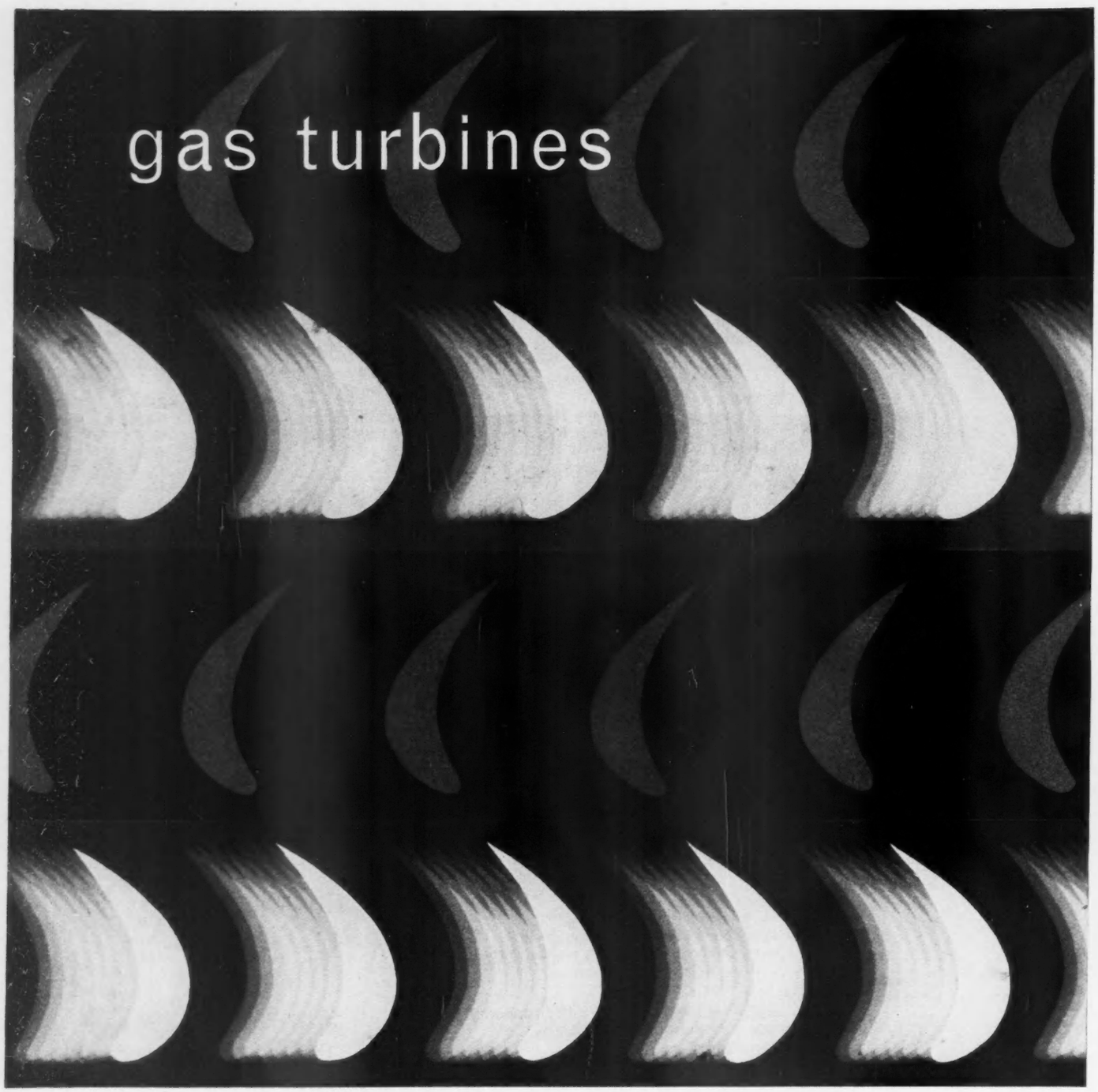

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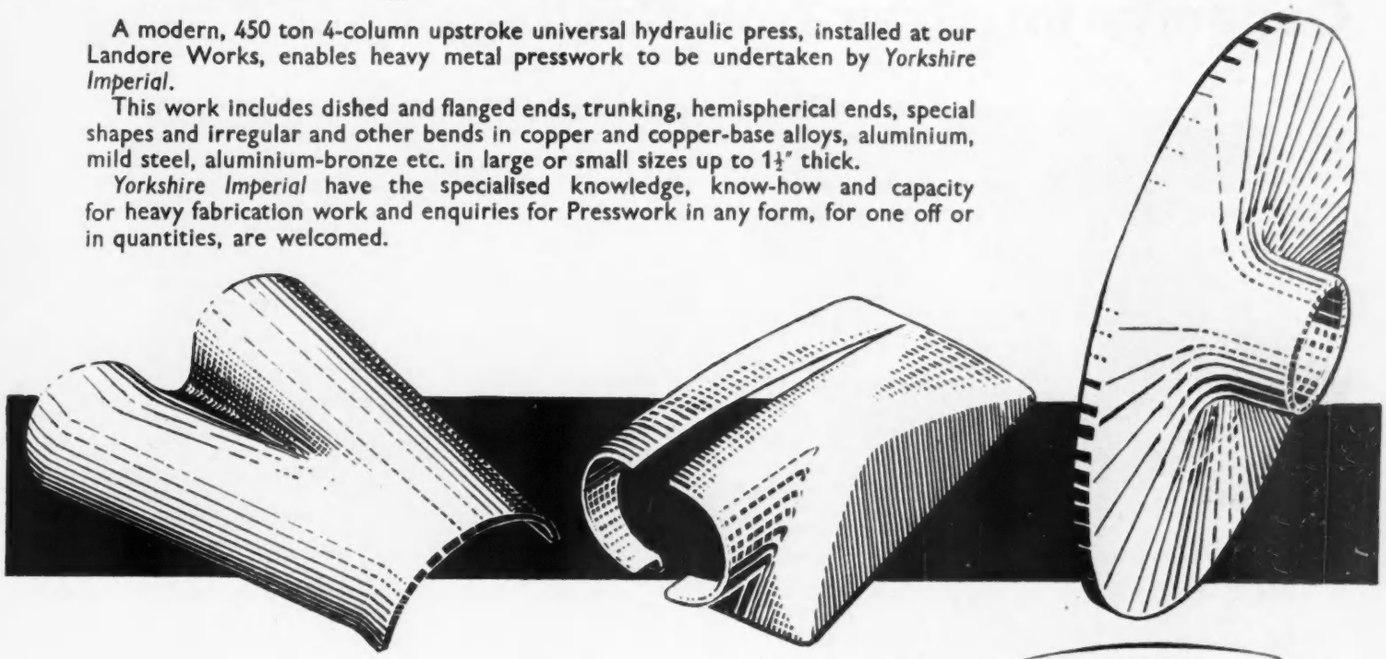

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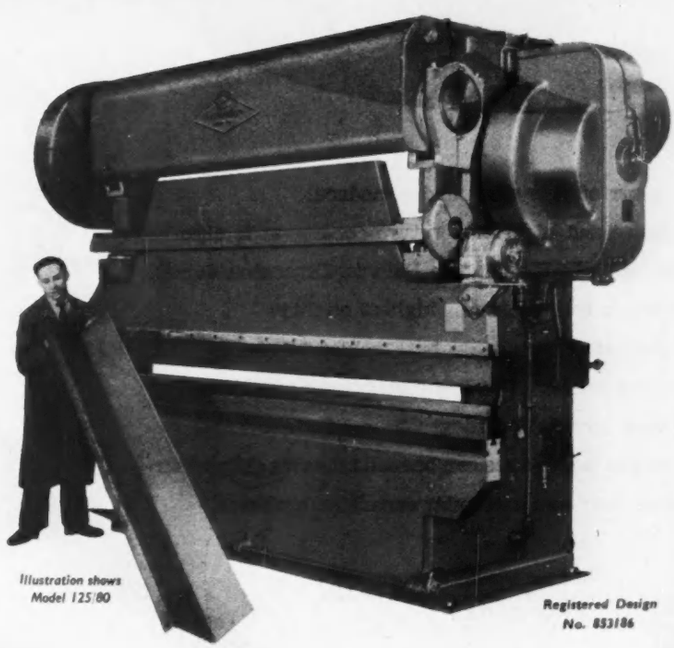

Illustration shows Model 125/80

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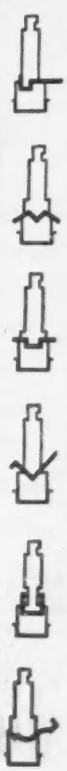

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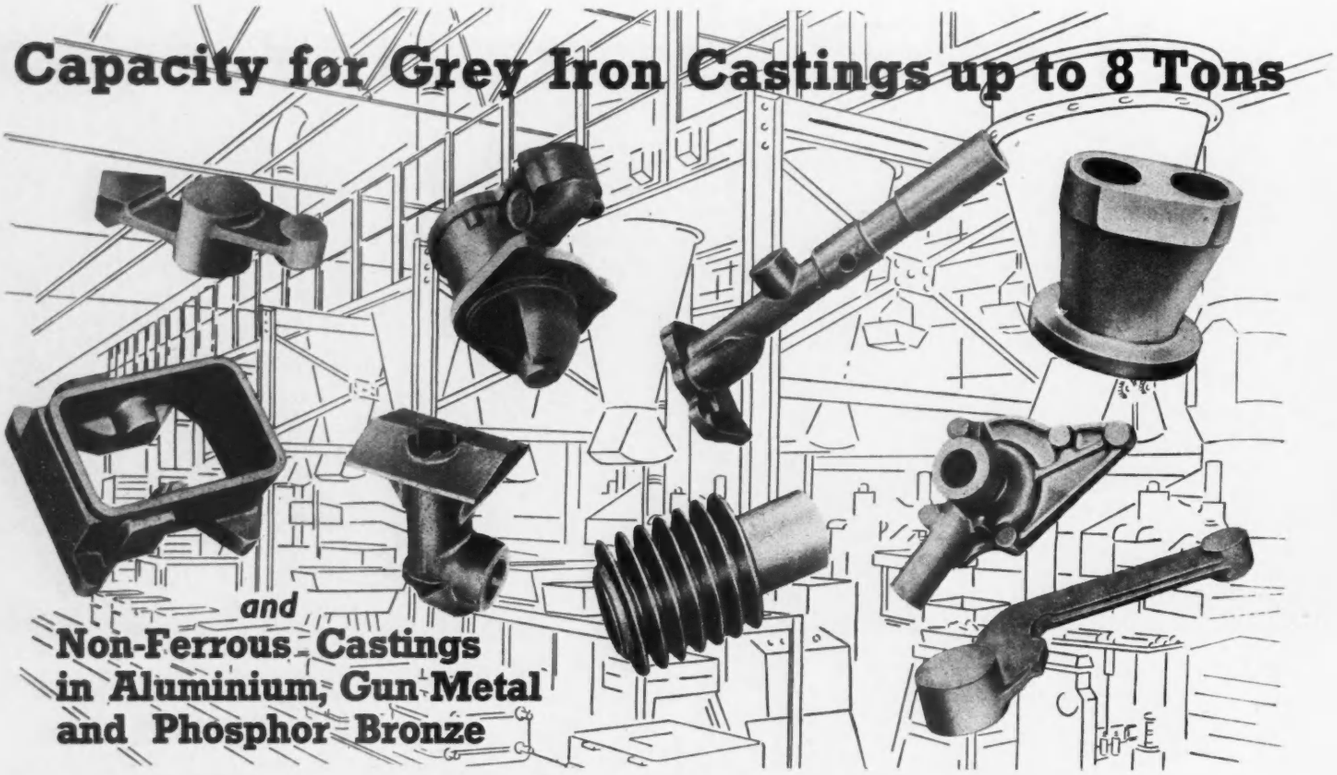

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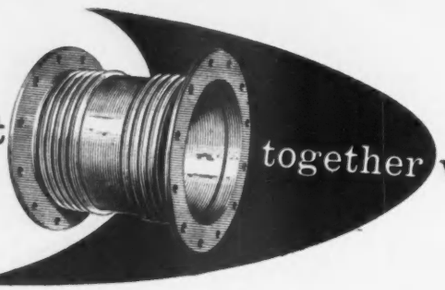
Let's get  together with . . .

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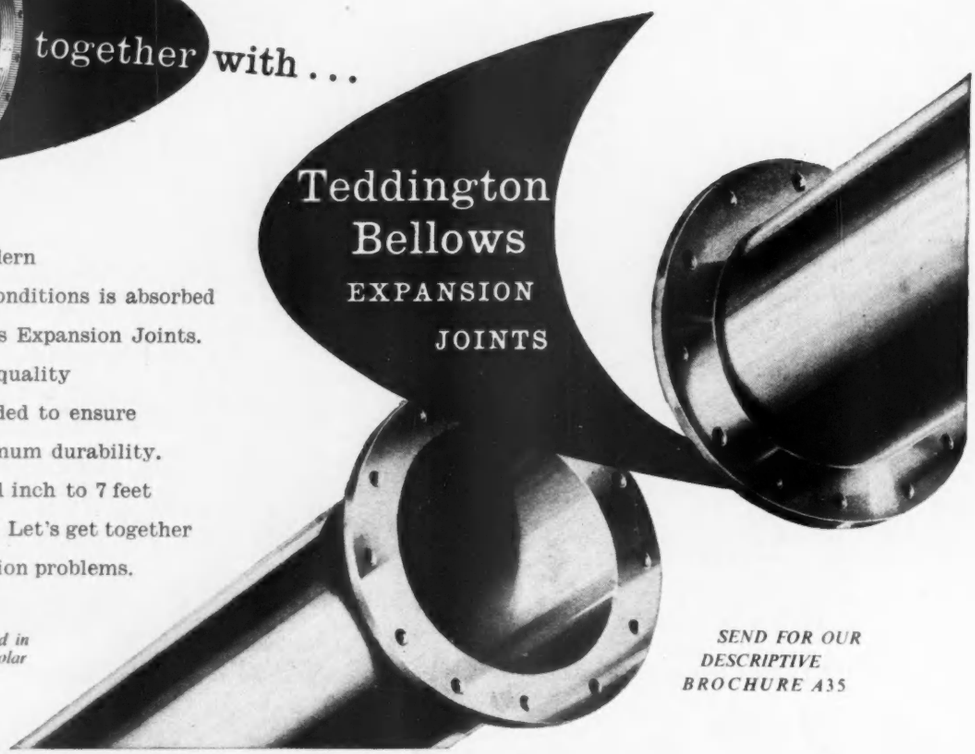

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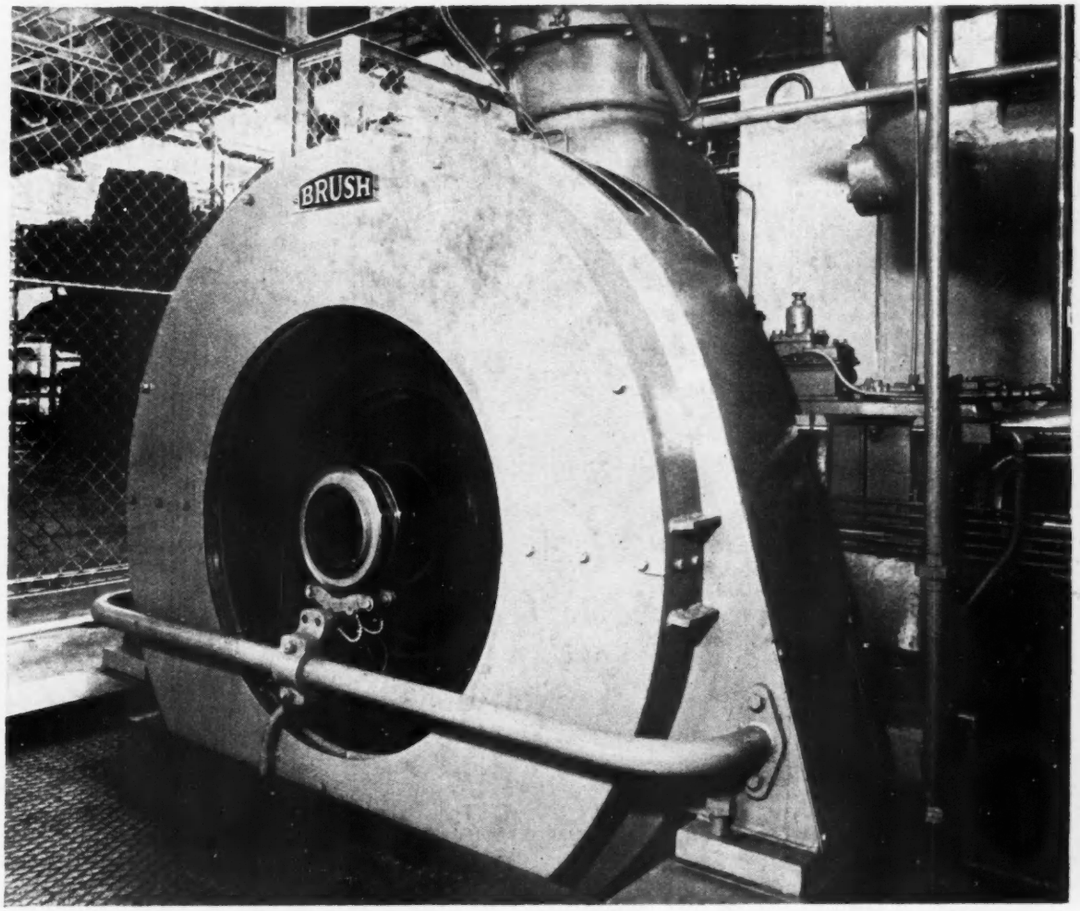

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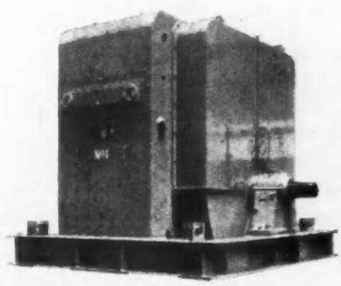

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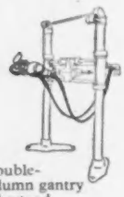

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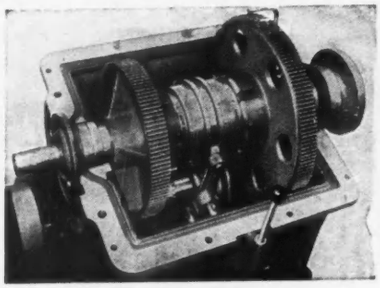

The illustrations show a typical application. The Reid Gear Co., Ltd., required a powerful, sensitive and completely trustworthy clutch unit for their two-speed reduction gear, to transmit the enormous effort applied in actuating the emergency sluice gate on a Scottish Hydro-Electric Project. The features mentioned above qualify Taylor Clutches to satisfy such exacting demands because they constitute the very ingredients of strength and reliability—the choice was a Taylor Multiple Disc Clutch.

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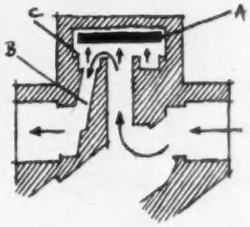
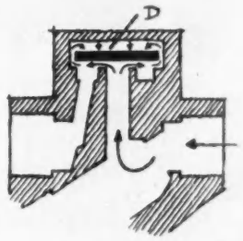
—how it works



Disc A is raised from seat by incoming pressure, allowing instant discharge of air and condensate through outlet B.

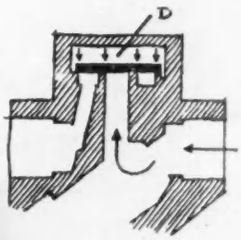
★

High velocity of following steam creates a low pressure area under disc and builds up pressure in chamber D.



★

Steam pressure in chamber D exceeds combined force of the incoming steam and the low pressure area. Acting on full top area of the disc, it forces it down and closes the inlet. On no load the valve is thus closed tight.



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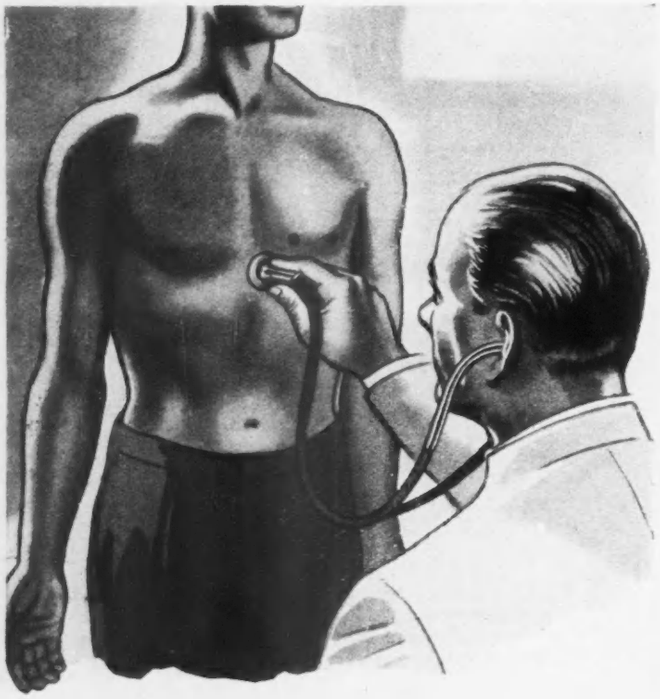

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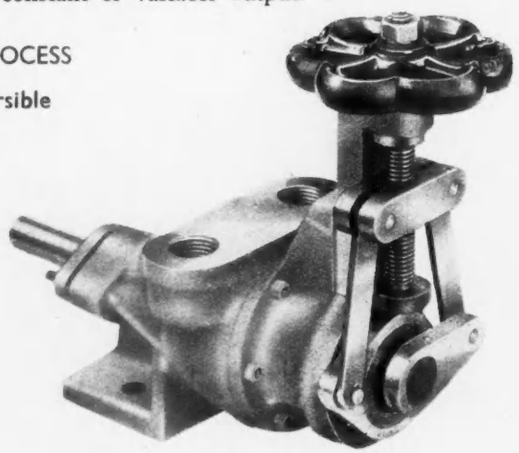

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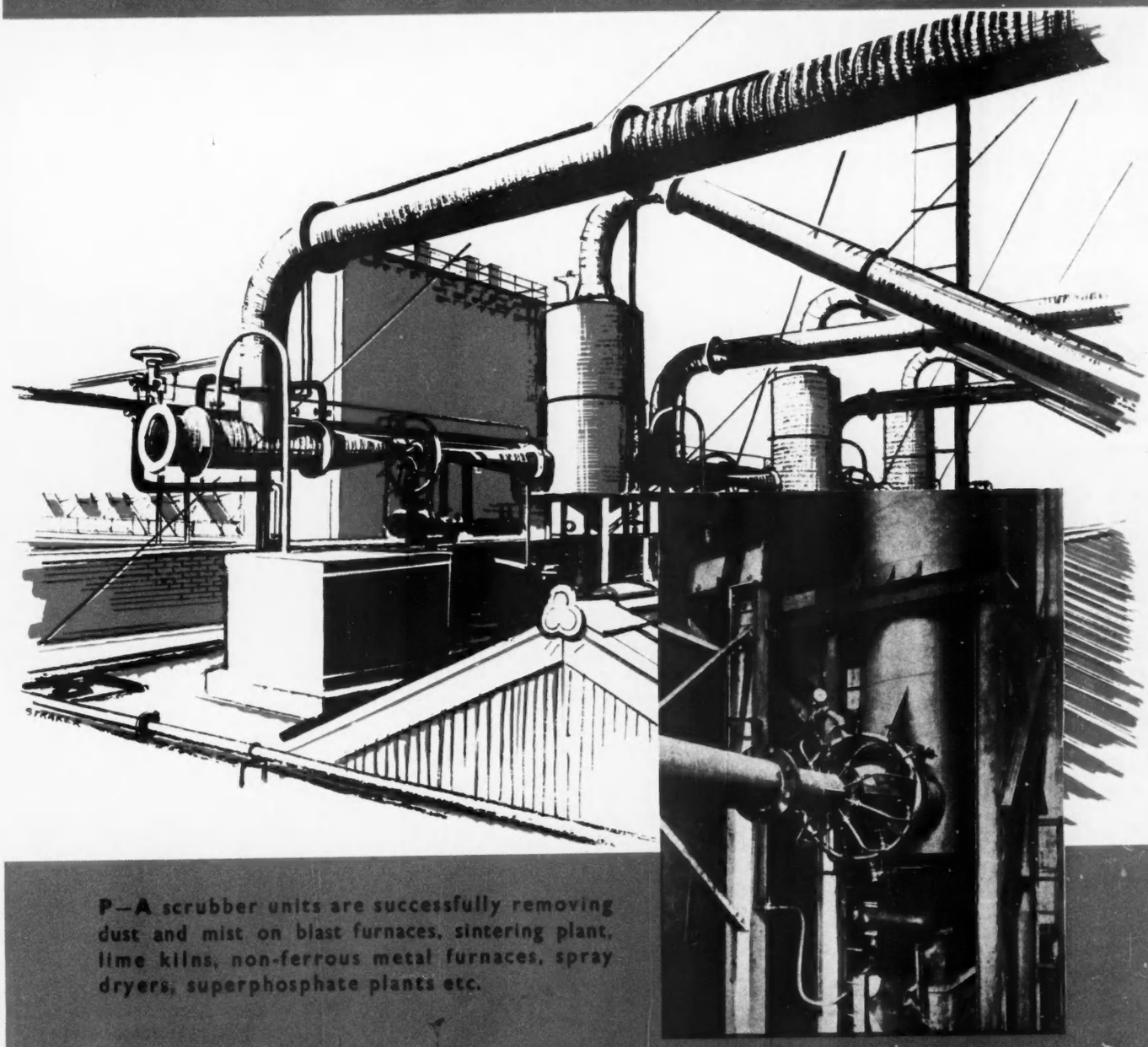

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Ferranti Ltd. have been awarded a contract by the Power Authority of the State of New York to supply thirteen generator transformers for the Lewiston Power Station of the Niagara Power Project, situated on the plateau on the Niagara River about 3 miles below the Falls in the town of Lewiston.

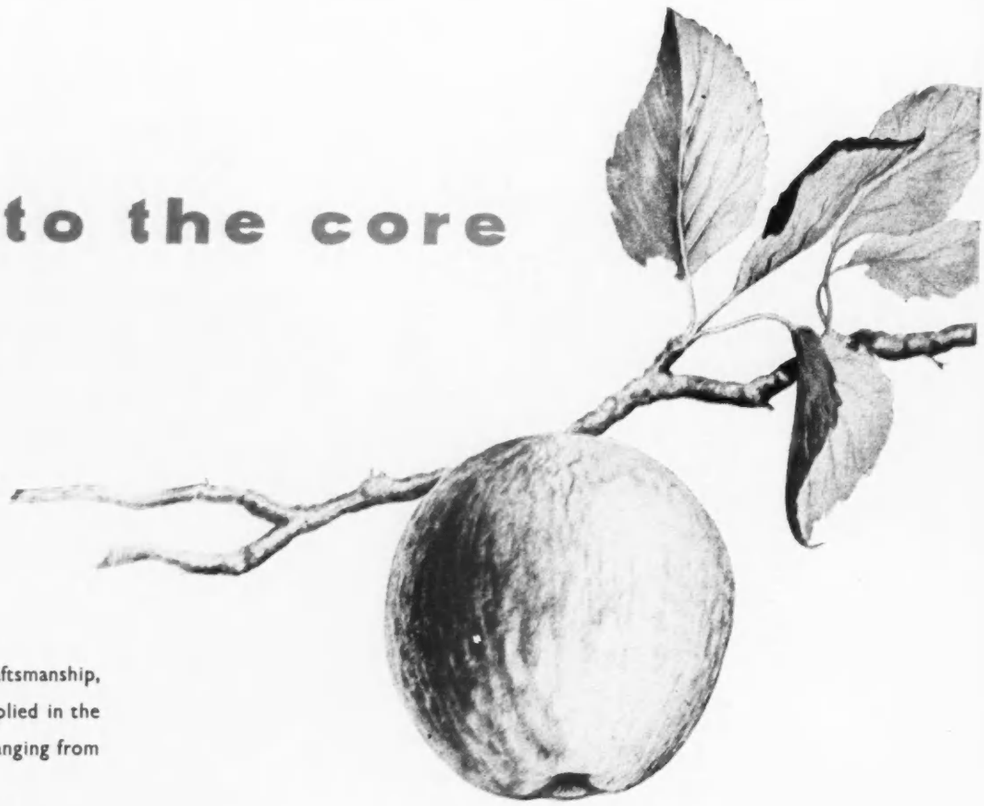
The contract covers six 180,000 kVA, 13.2/240 kV 3-phase transformers and seven 180,000 kVA, 13.2/120 kV 3-phase transformers. They will be of the forced-oil, forced-water cooled, inert gas-filled type and each will be directly coupled to a 167,000 kVA 3-phase generator.

Believed to be the largest transformer contract so far placed in Britain by the U.S.A., delivery will commence in the middle of 1959 and will be completed by the end of 1960.

FERRANTI

FT 216/2

Sound to the core



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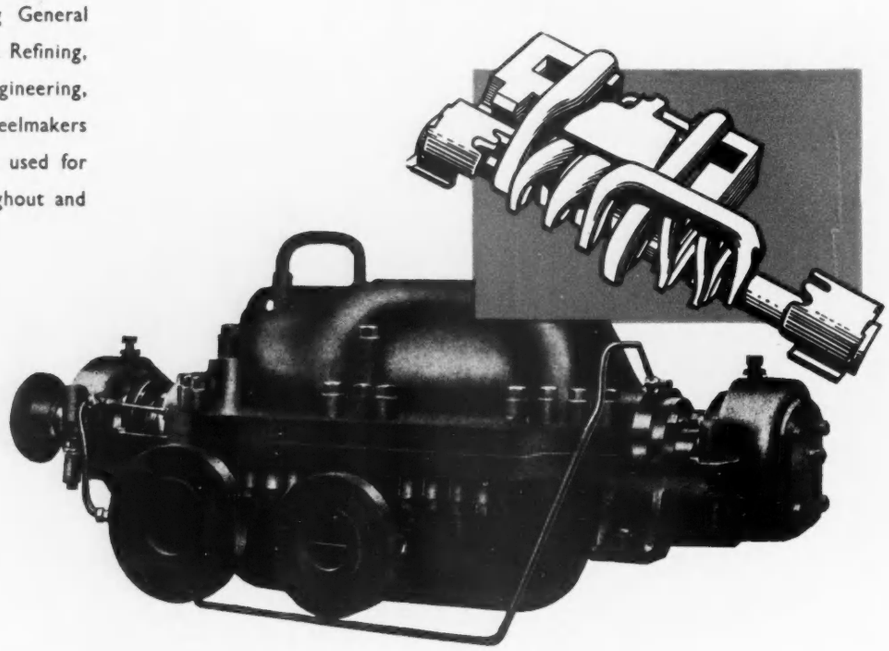

Osborn castings are used in this *Hayward Tyler - Byron Jackson six stage 'Multiplex' pump.* Inset illustrates core used for casting the upper half of casing.

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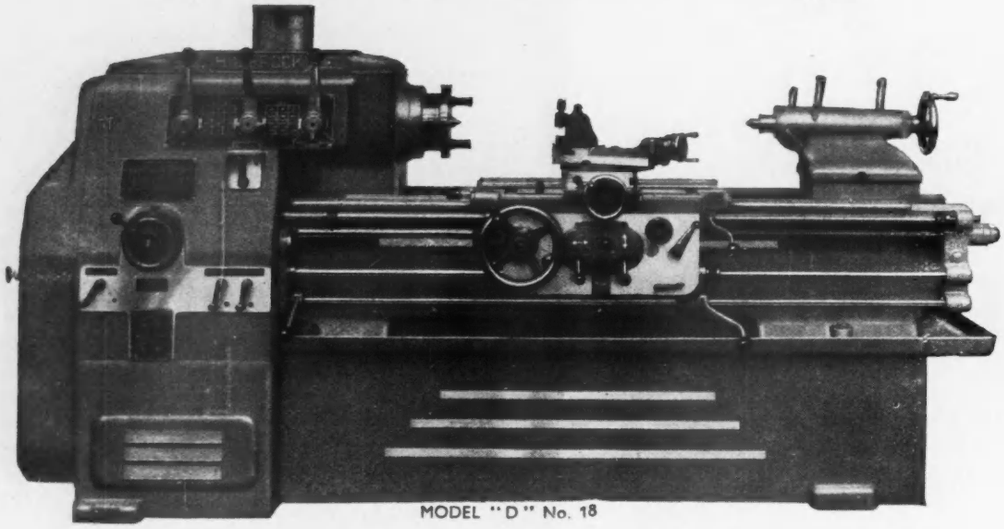

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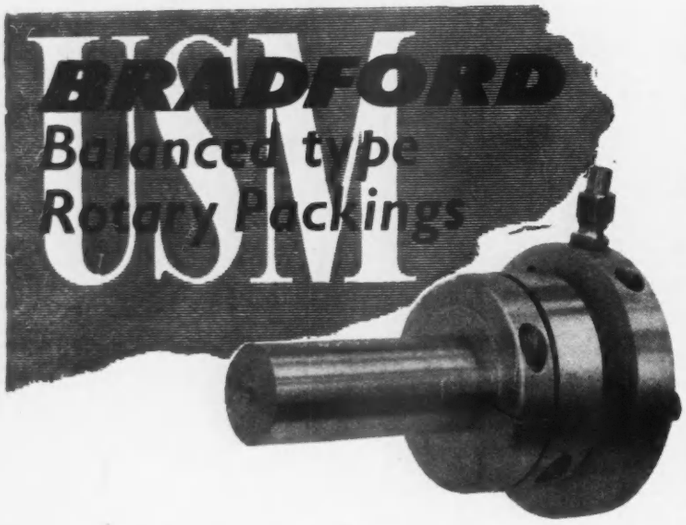

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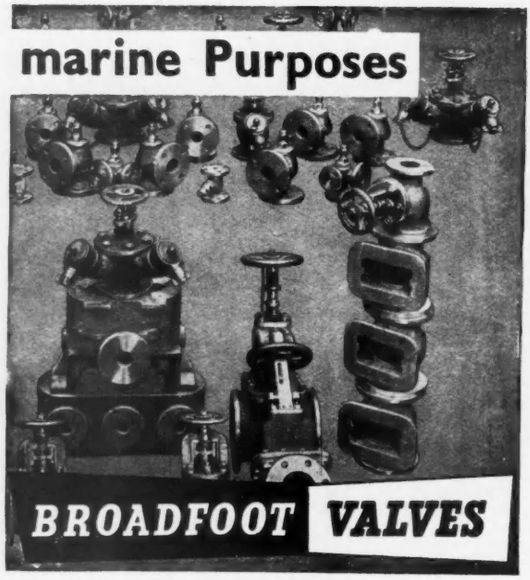

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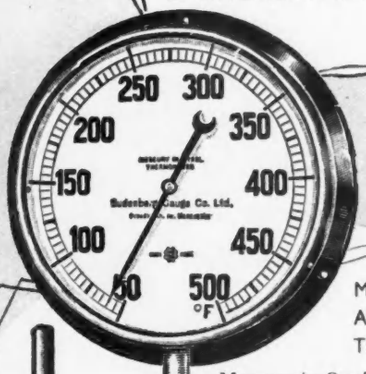

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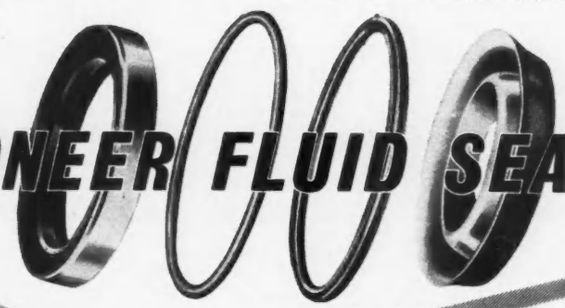

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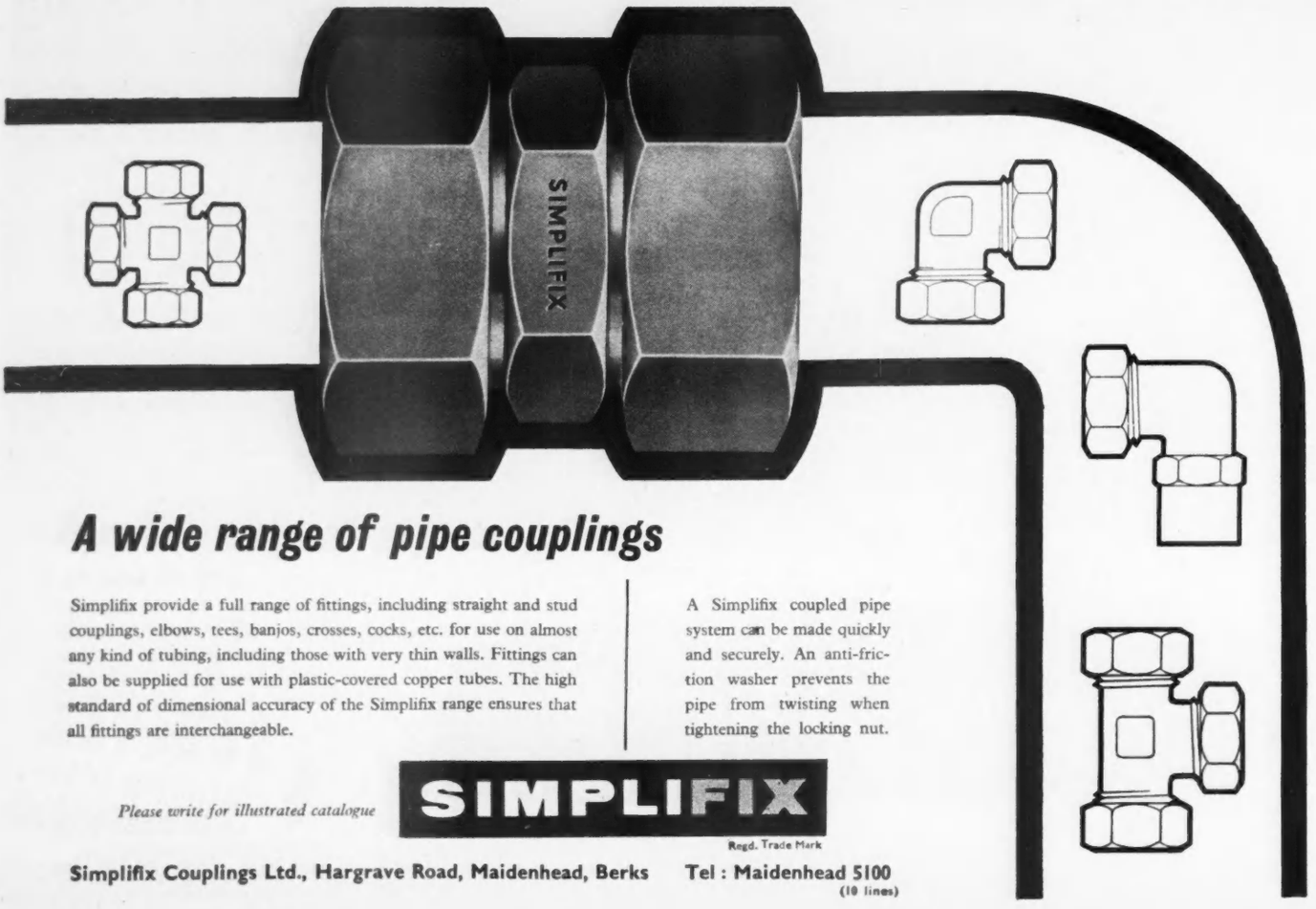

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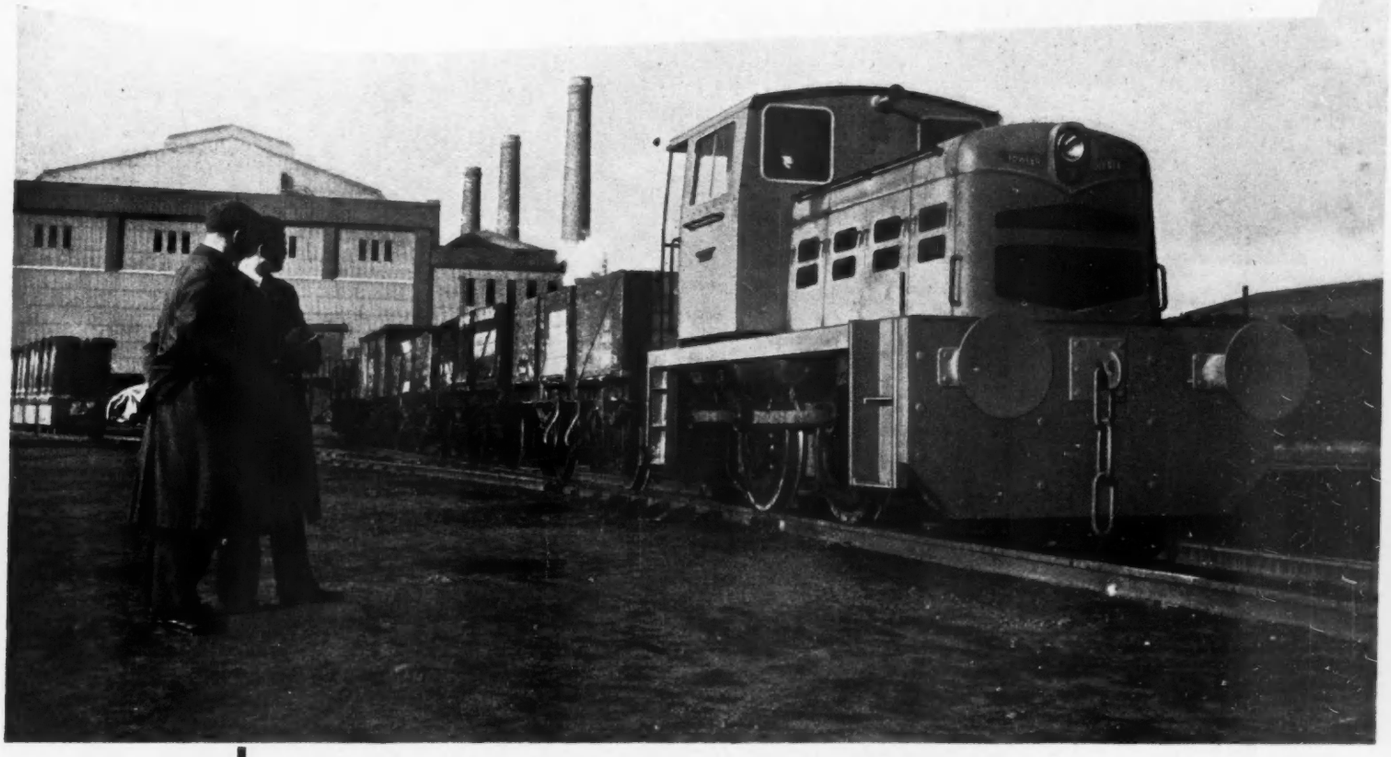

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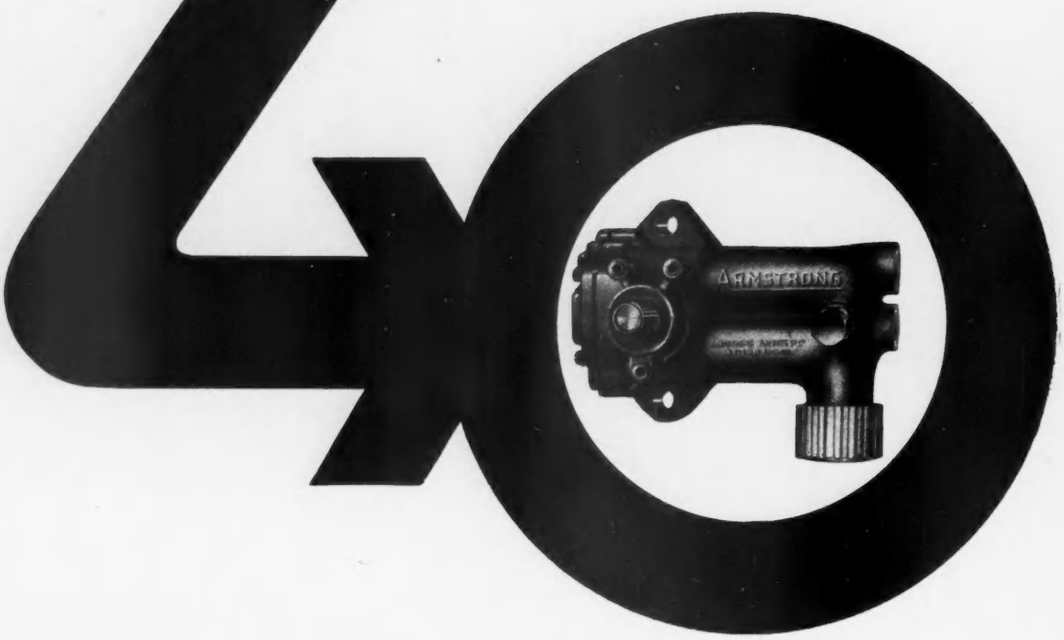

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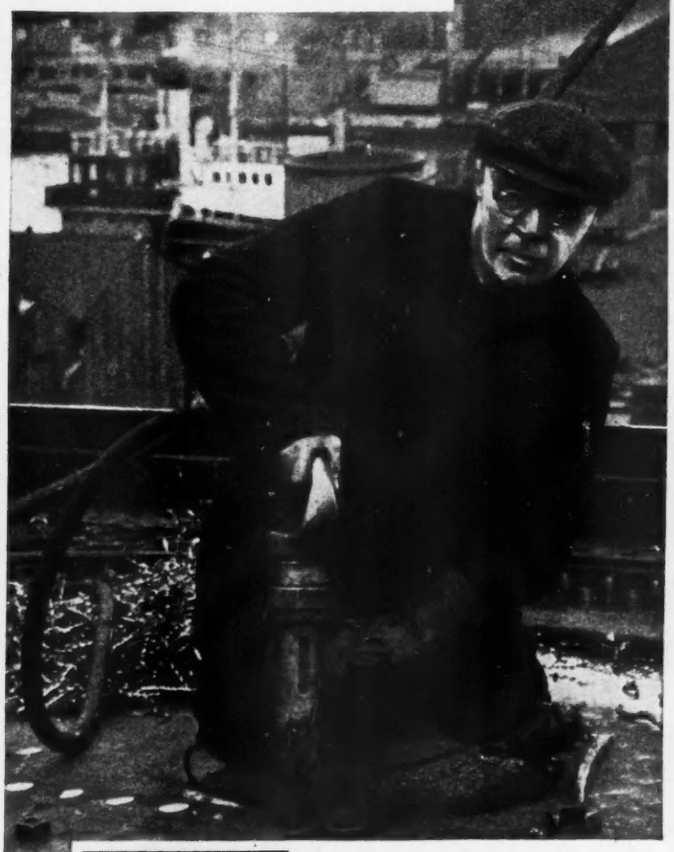

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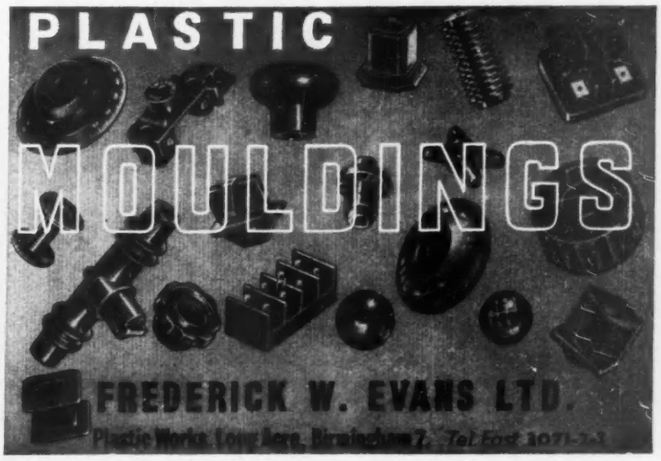

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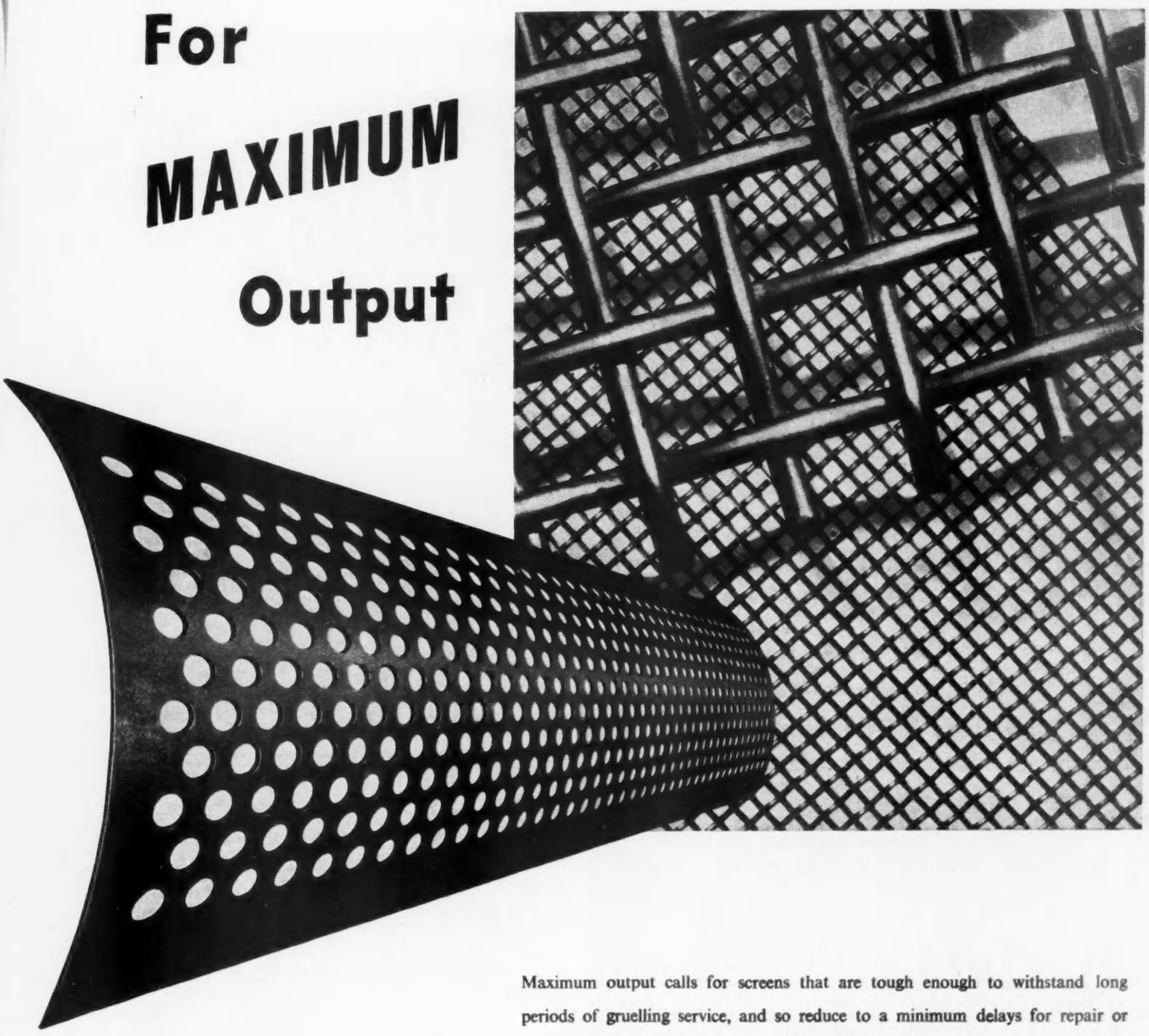

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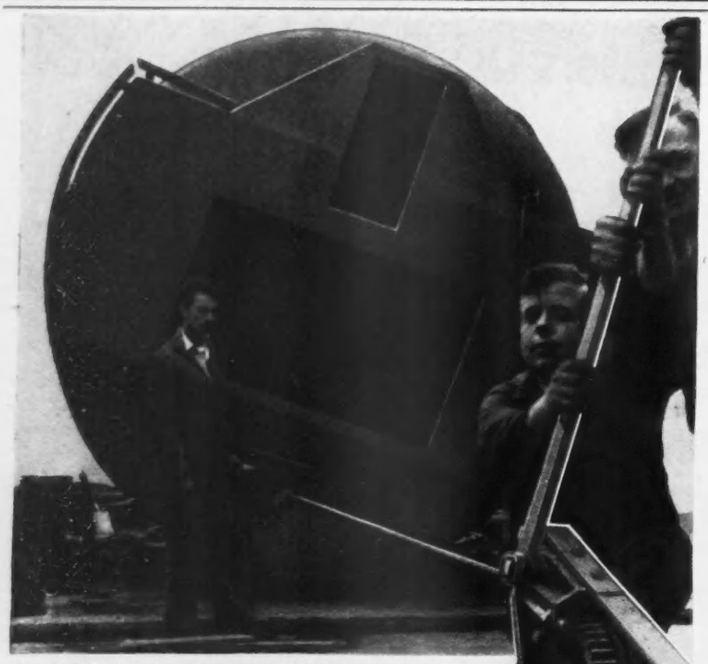

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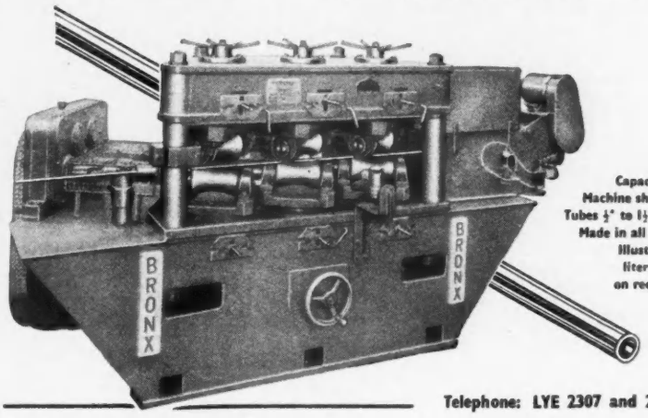

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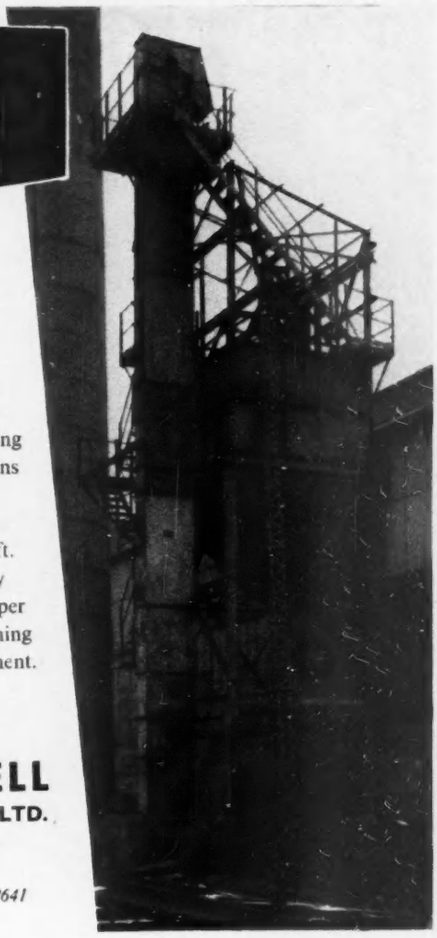

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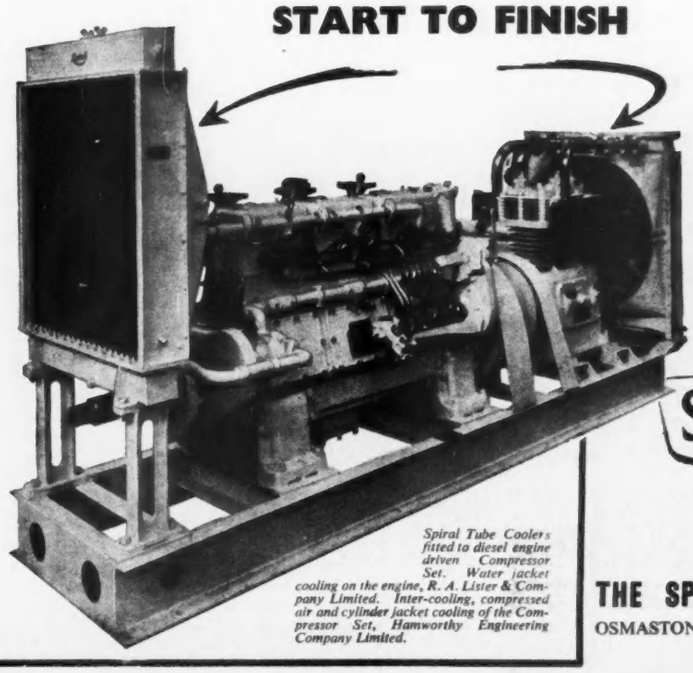

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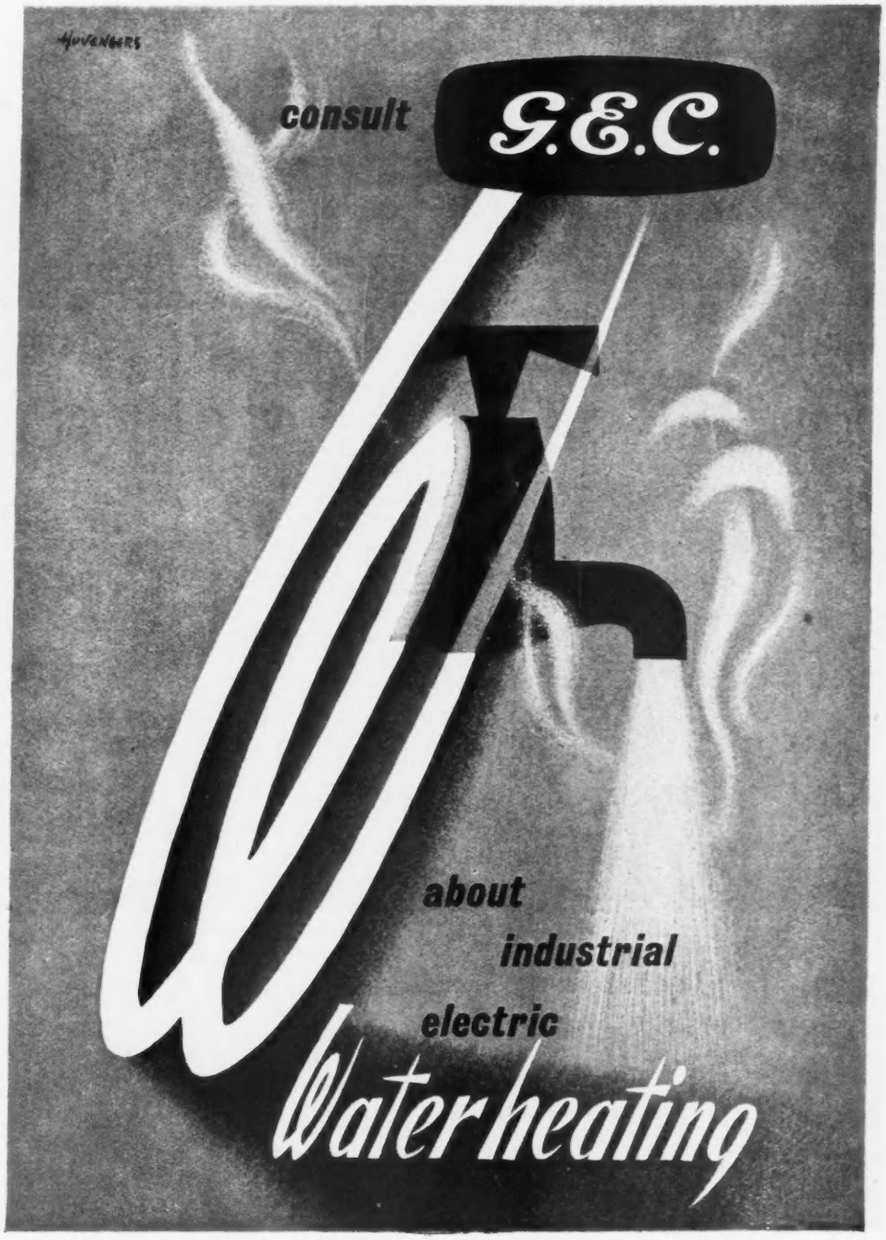

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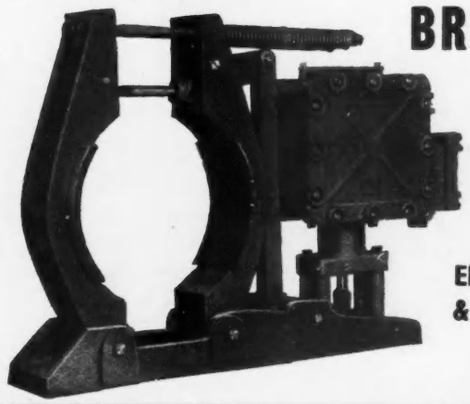

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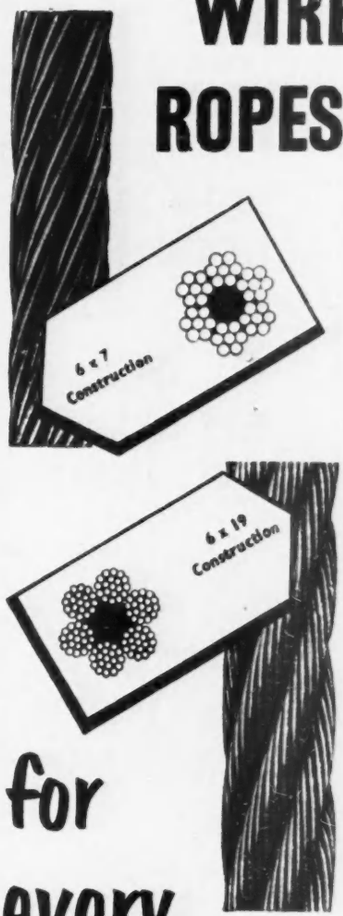

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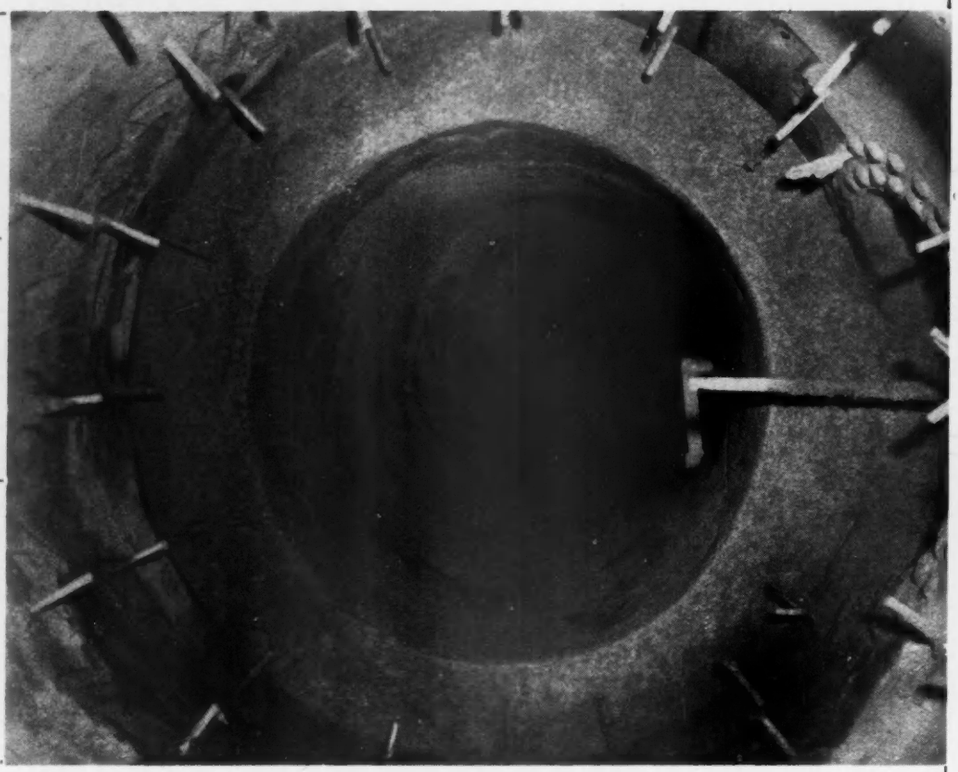

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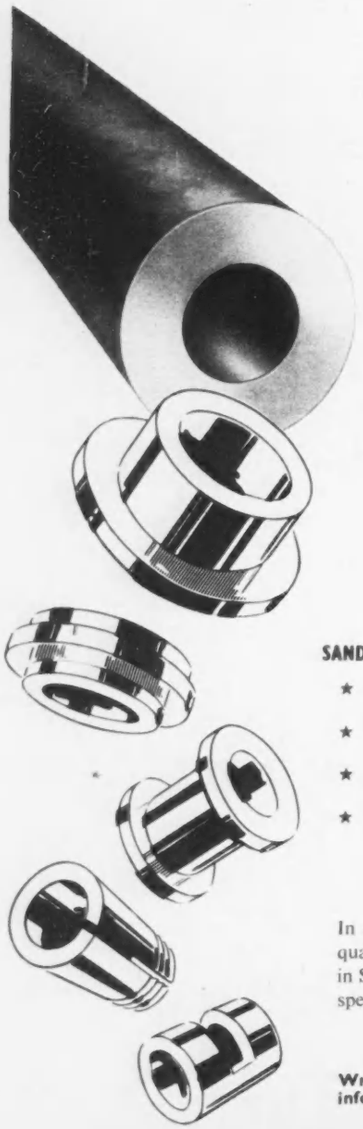

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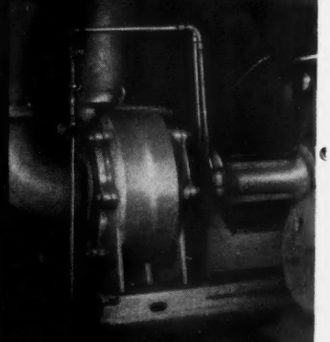

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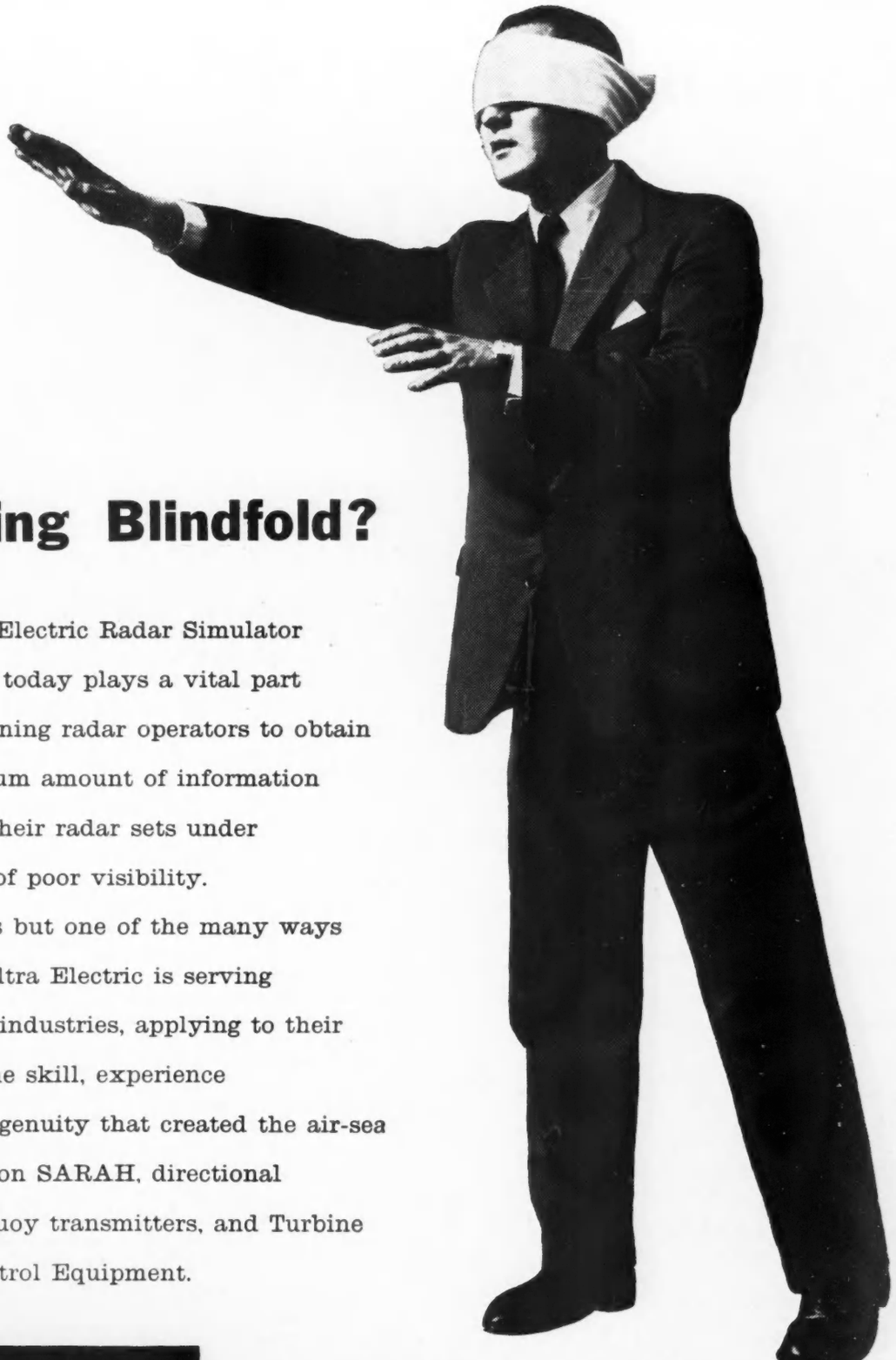

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● **BOOSTS HEAT OUTPUT . . .** Whatever type of oil-burning equipment is used the addition of FLAME-RITE to the fuel improves flame efficiency. A surface tension agent ensures complete and even atomization of all fuel passing through the burner, exposing the maximum surface area of fuel to the air supply, and so ensuring the hottest possible flame from any given amount of fuel.

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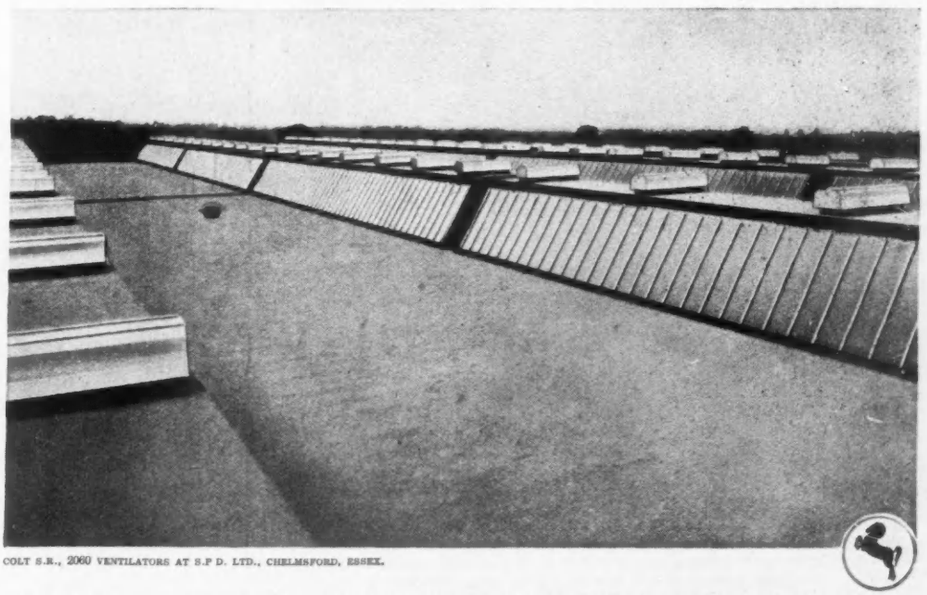

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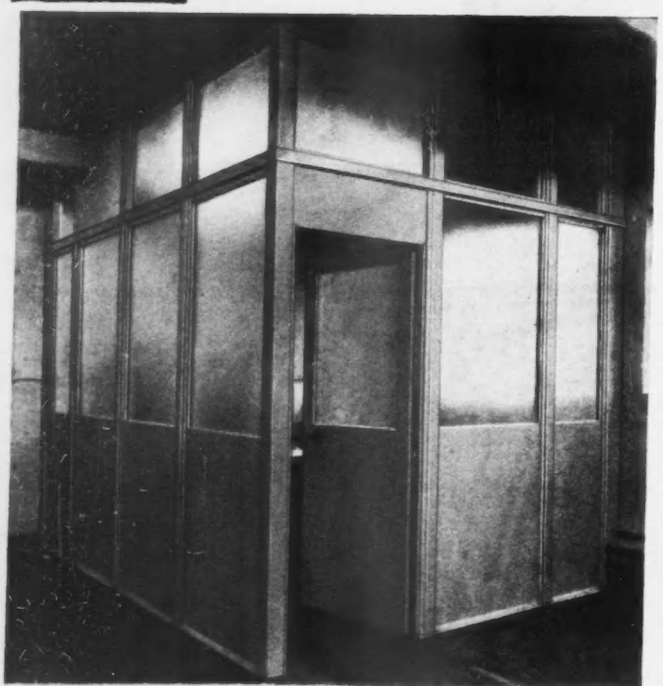

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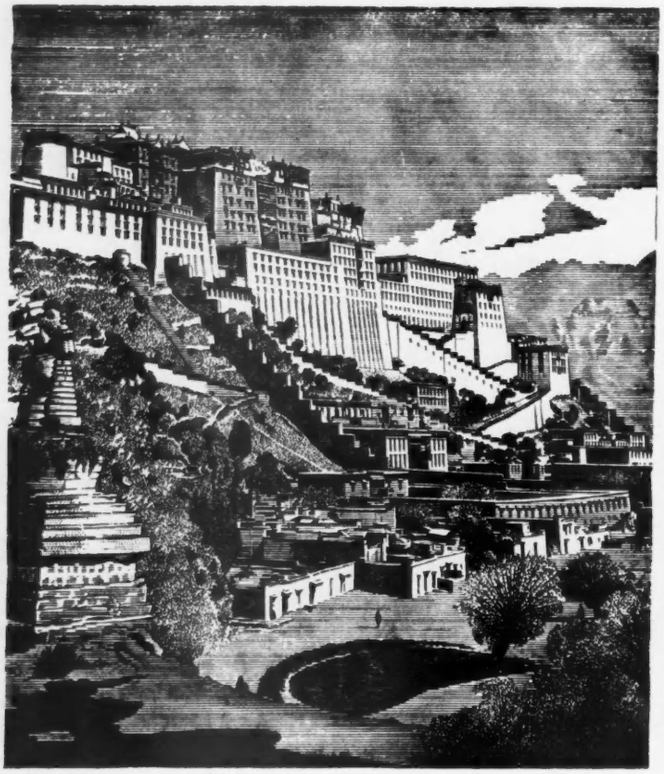

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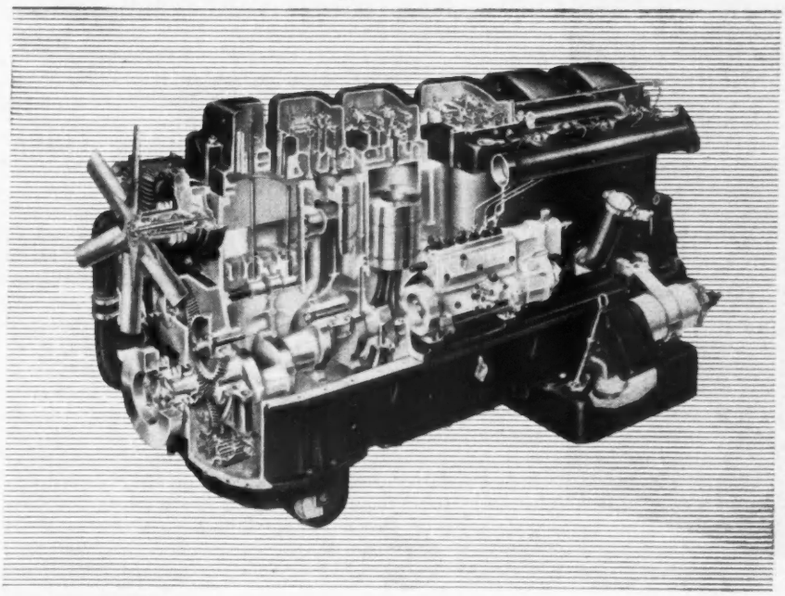

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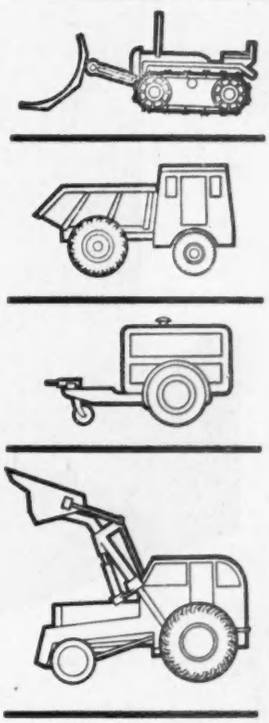

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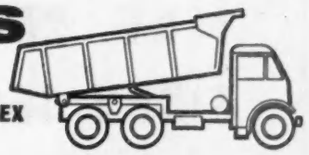

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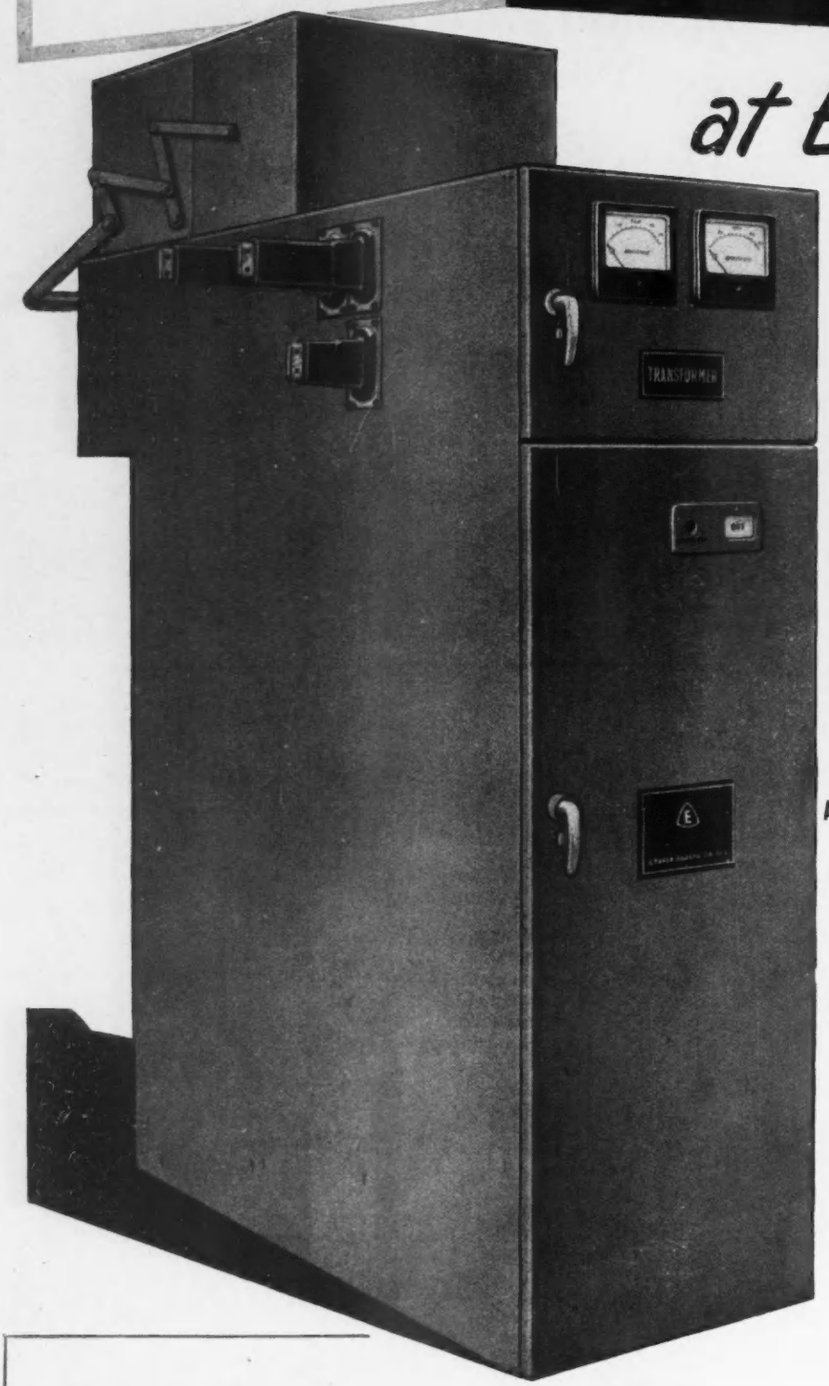

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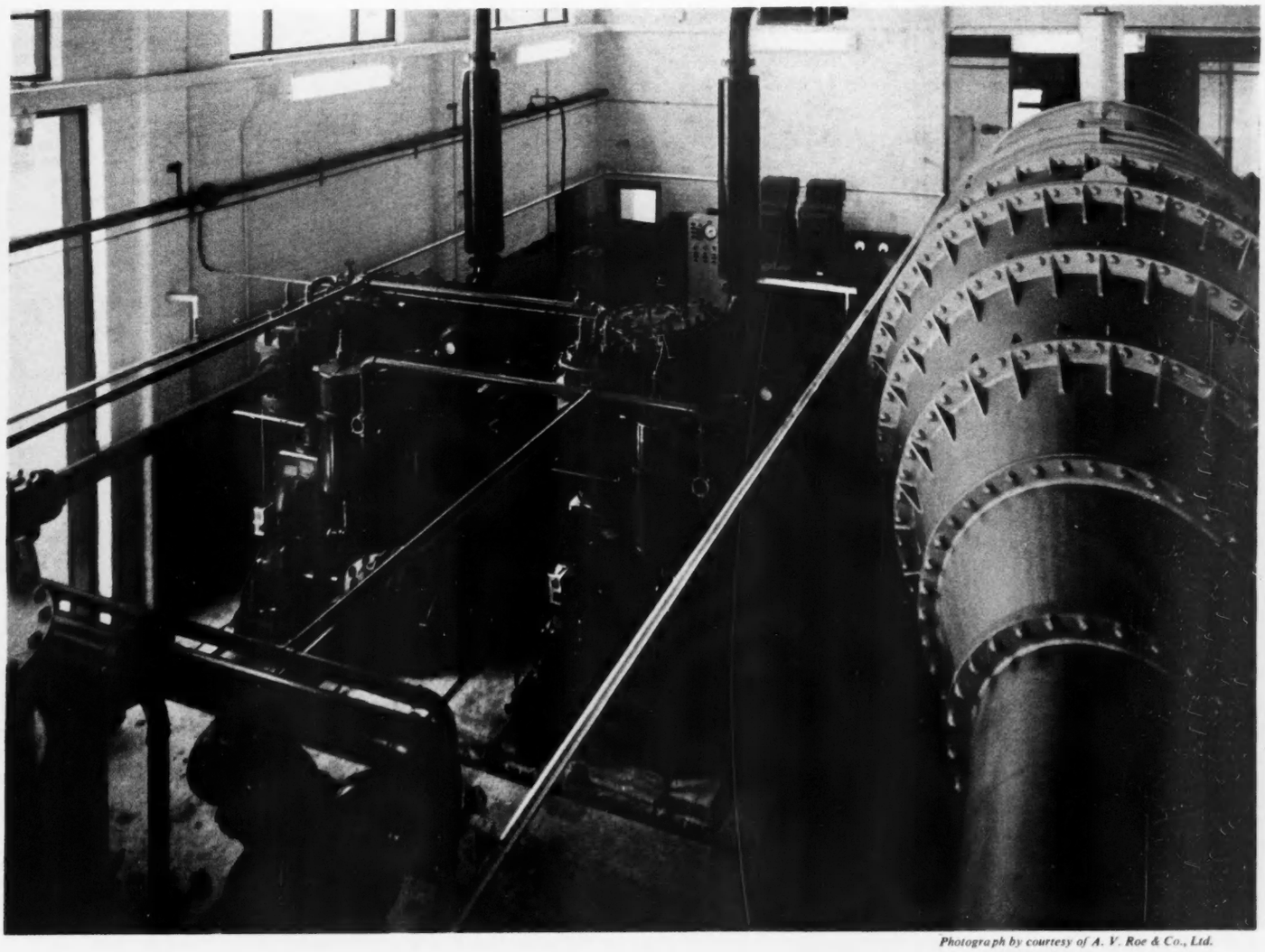

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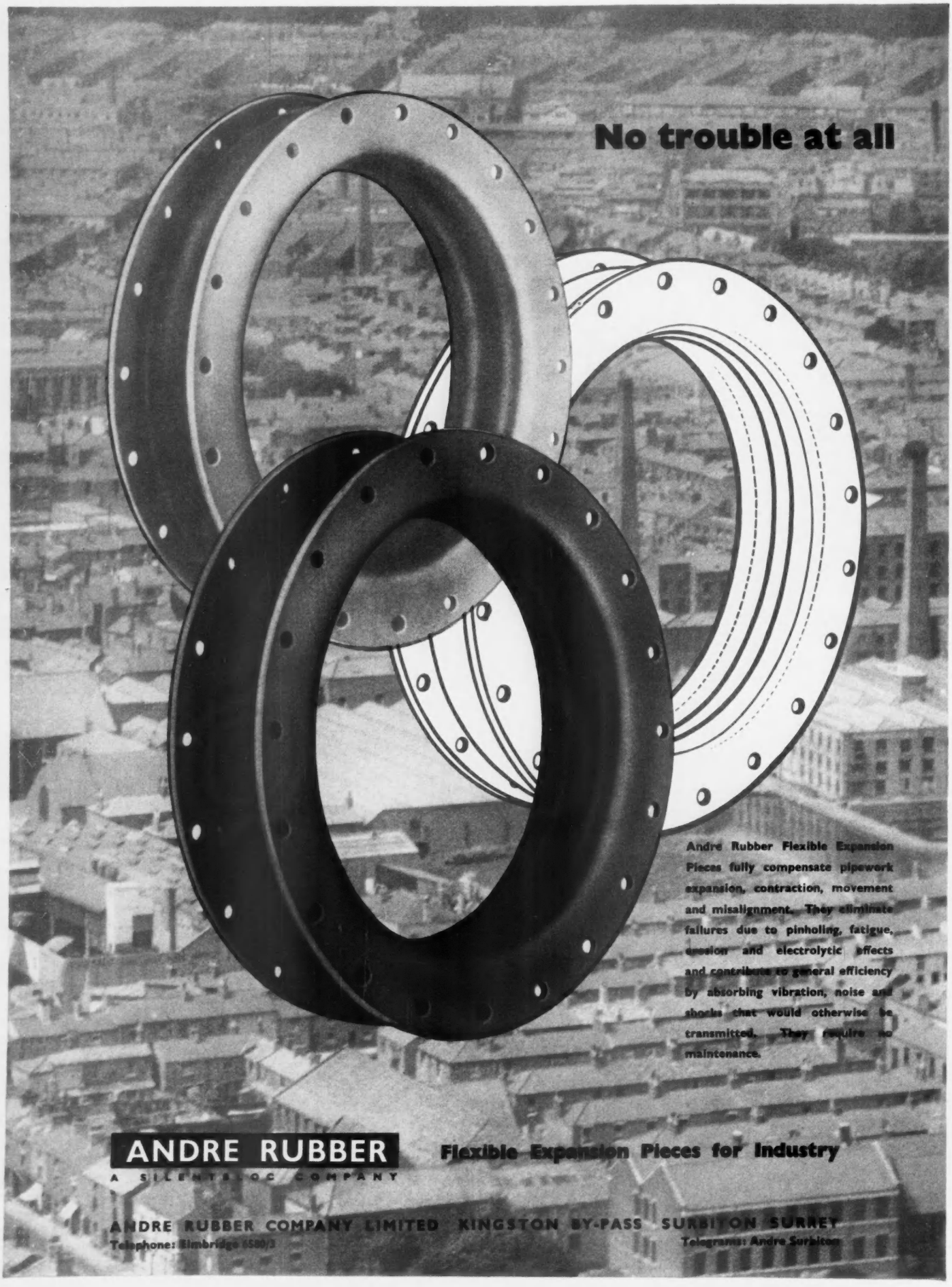
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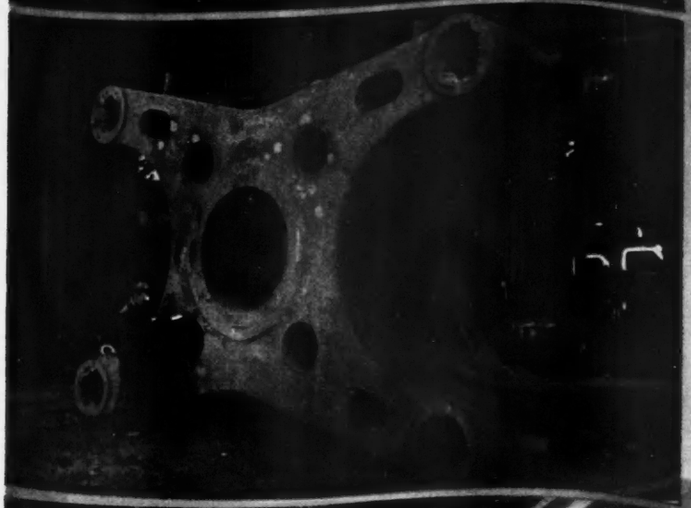

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The yellow section shows this construction; in red is the 36″ by 16½″ universal beam, in blue the 24″ by 12″, previously the largest rolled in this country, now available in three weights, and in grey is shown the largest of the B.S. sections, 24″ by 7½″. By way of contrast the little white section is the B.S. 3″ by 1½″, the smallest I section rolled by us.

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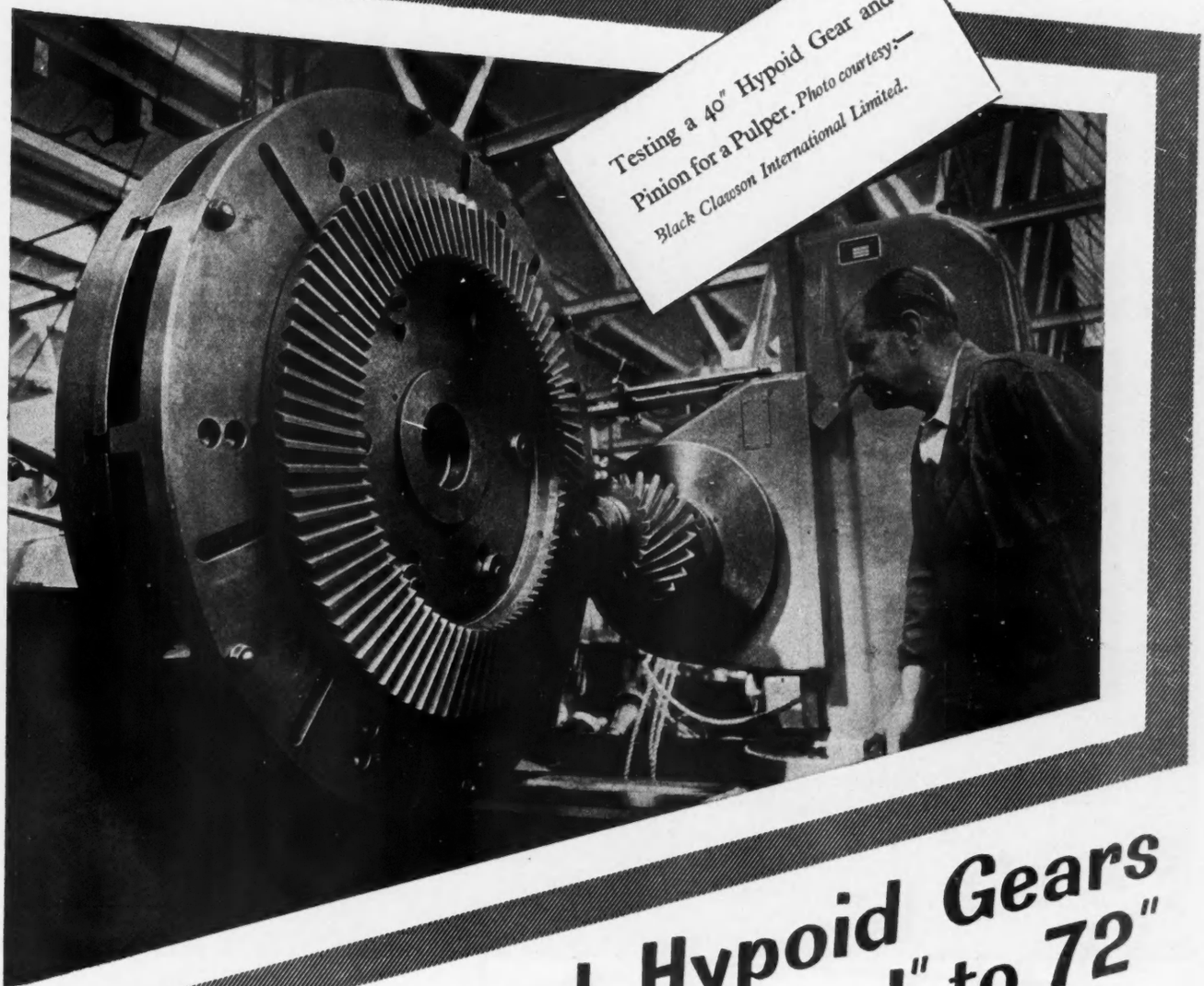

Testing a 40" Hypoid Gear and Pinion for a Pulper. *Photo courtesy:— Black Clawson International Limited.*

Spiral Bevel and Hypoid Gears from 1" to 72"

Spiral bevel and hypoid gears offer many advantages for right angle drives where high efficiency and smooth, silent running are required.

E.N.V. specialise in the design and manufacture of straight and curved tooth bevel gears. They offer collaboration with engineers from the project stage on the design of gears and mountings. They have unique facilities for the large-scale manufacture of transmissions including final drives, differentials and axles for vehicles and agricultural equipment, precision gears for aircraft and gears for industrial applications.

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AP 56

F

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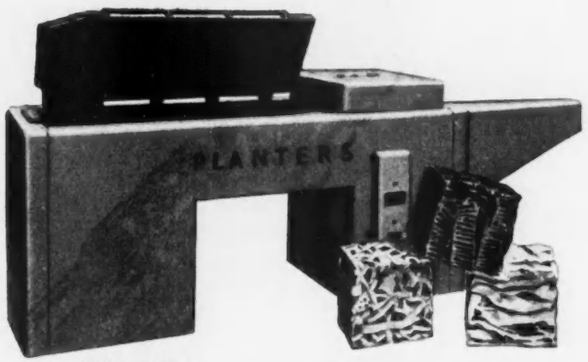

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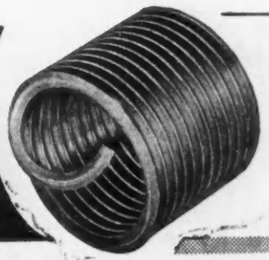

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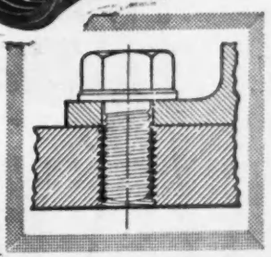

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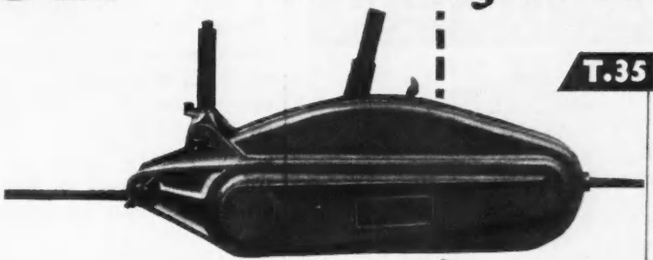
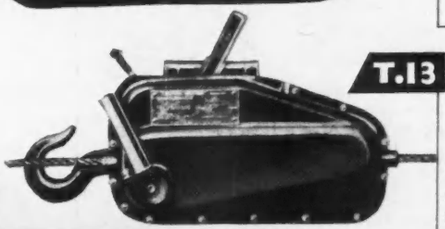


T.35

CAPACITY	LIFTING (SWL) 3 TONS PULLING 5 TONS
EFFORT	70/120 LBS.
WEIGHT	59 LBS.
SPEED	3/9 FT. PER MIN
SIZE	28¼" x 12½" x 5½"
MECH. ADV.	85 : 1



T.13

CAPACITY	LIFTING (SWL) 1 TON PULLING 30 CWT.
EFFORT	77 LBS.
WEIGHT	39 LBS.
SPEED	11½ FT. PER MIN
SIZE	24" x 12" x 6"
MECH. ADV.	43 : 1

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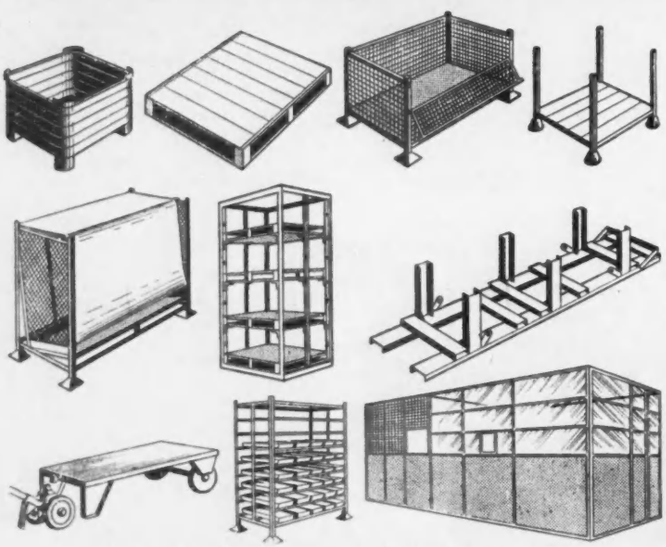

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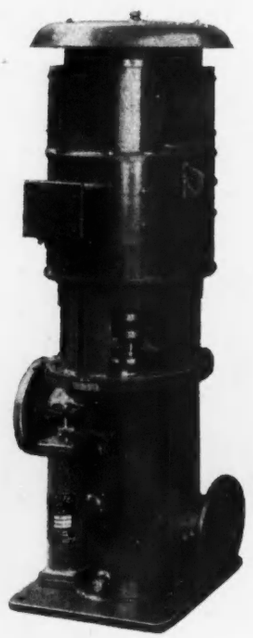

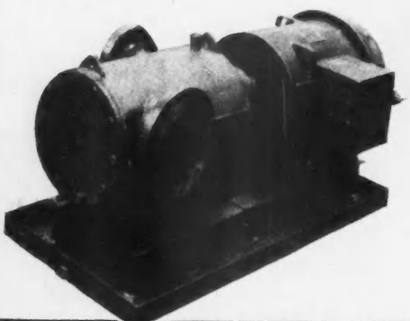

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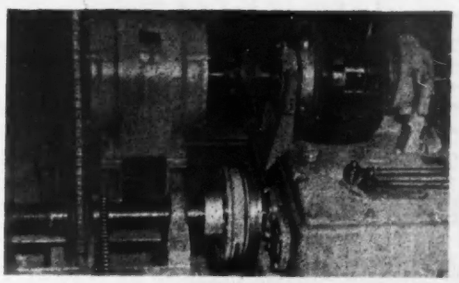
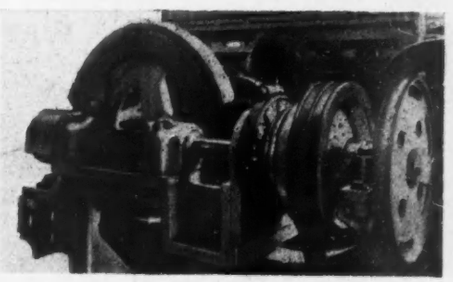


Fully automatic re-winding machine showing a Warner 825 Clutch Coupling incorporated in the main drive.
The General Engineering Company (Radcliffe) Ltd., Radcliffe.



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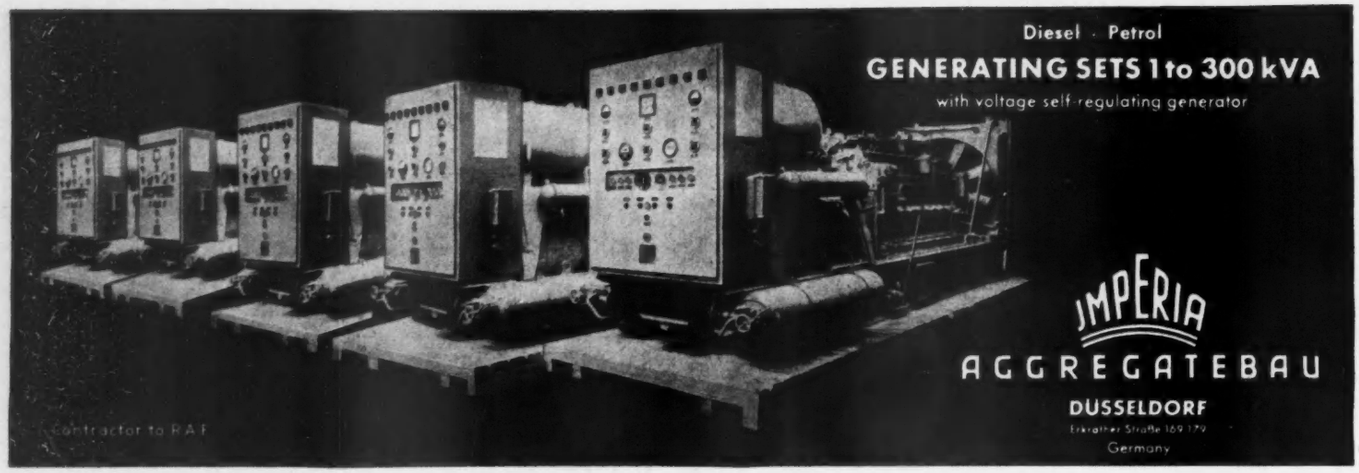

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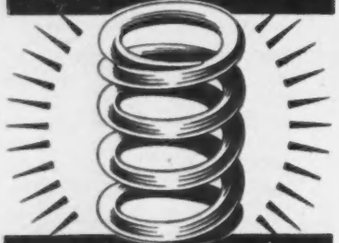

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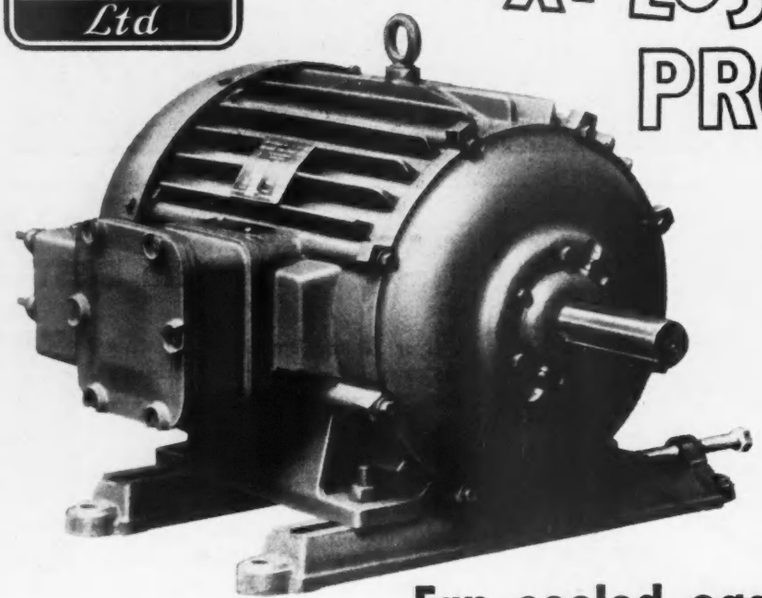

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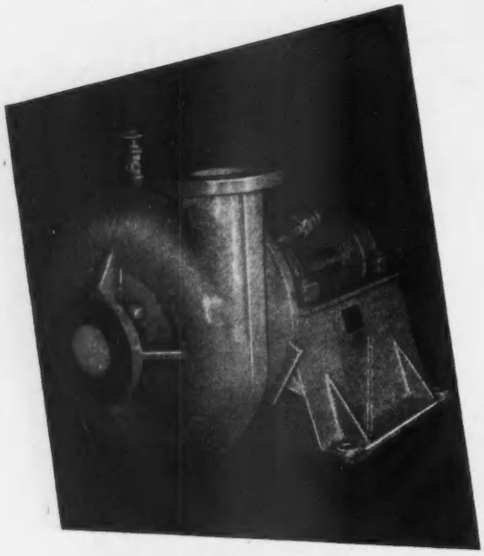

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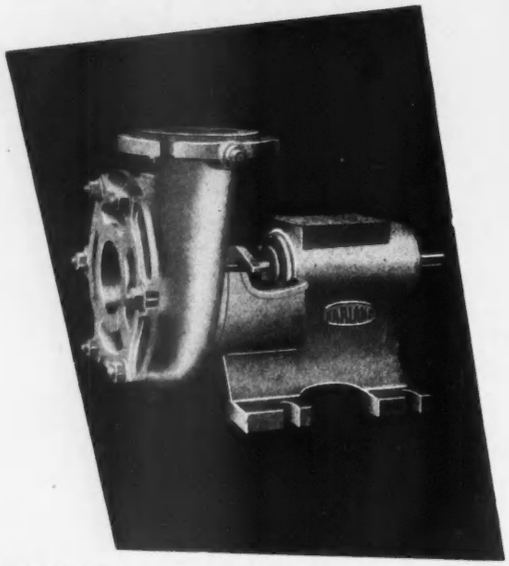

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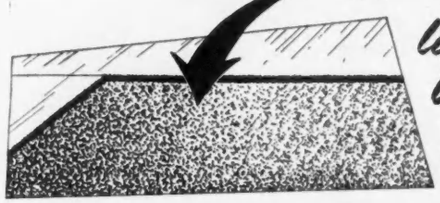

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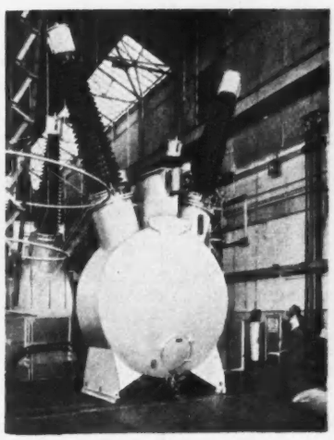

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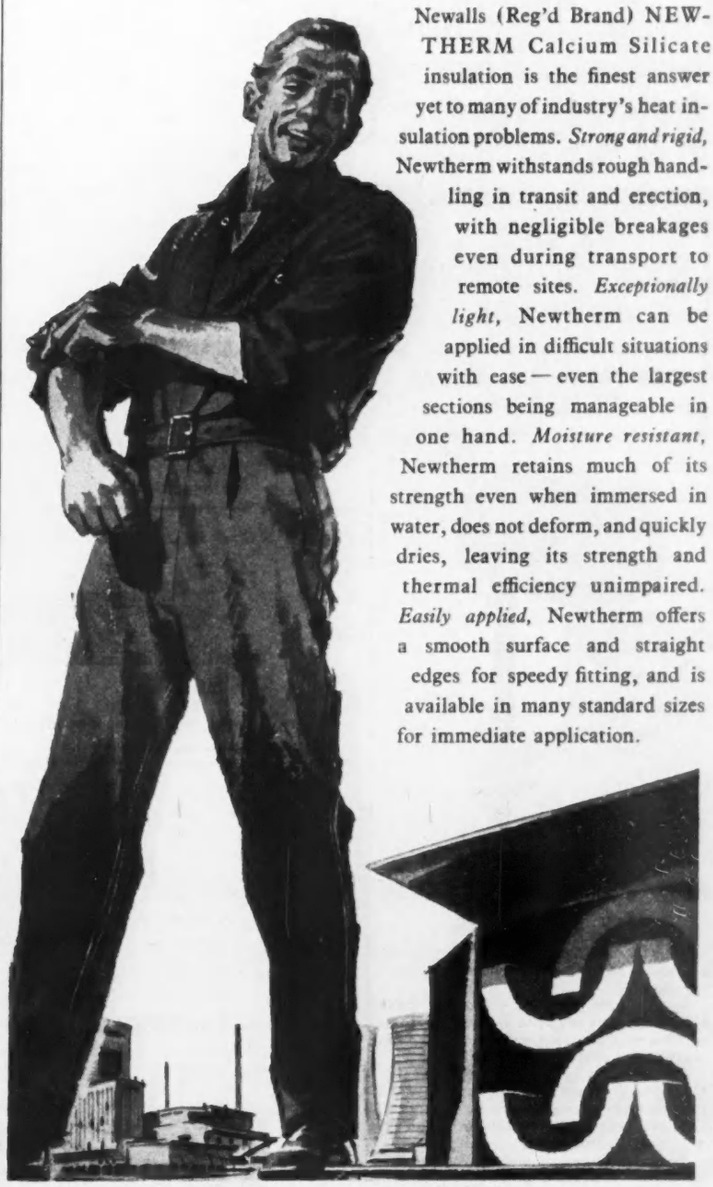

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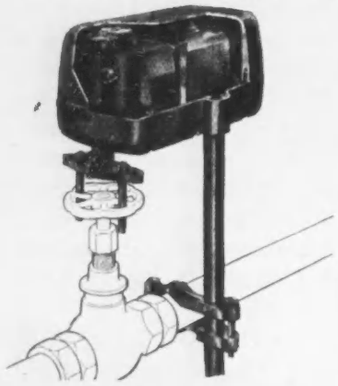

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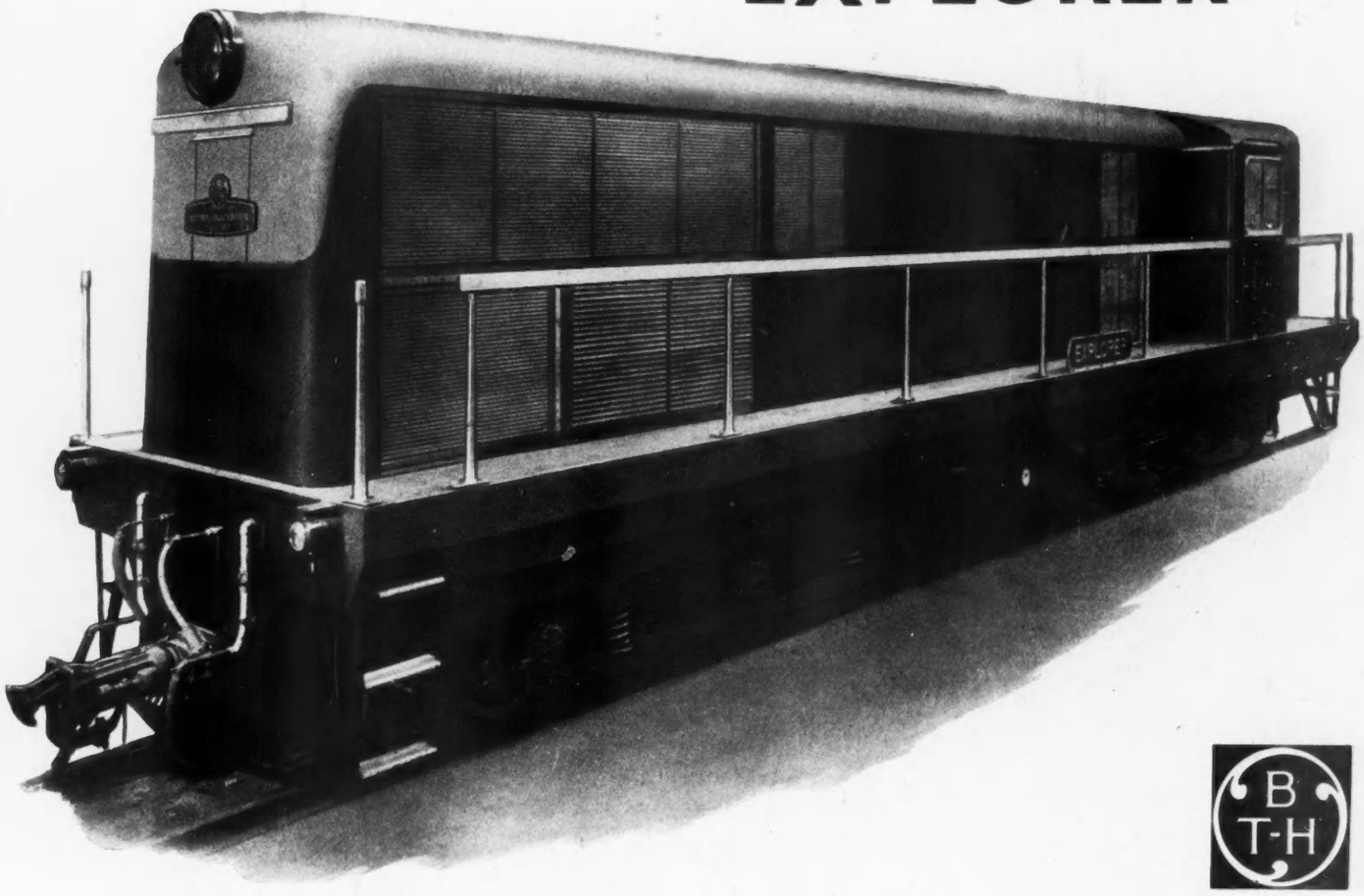

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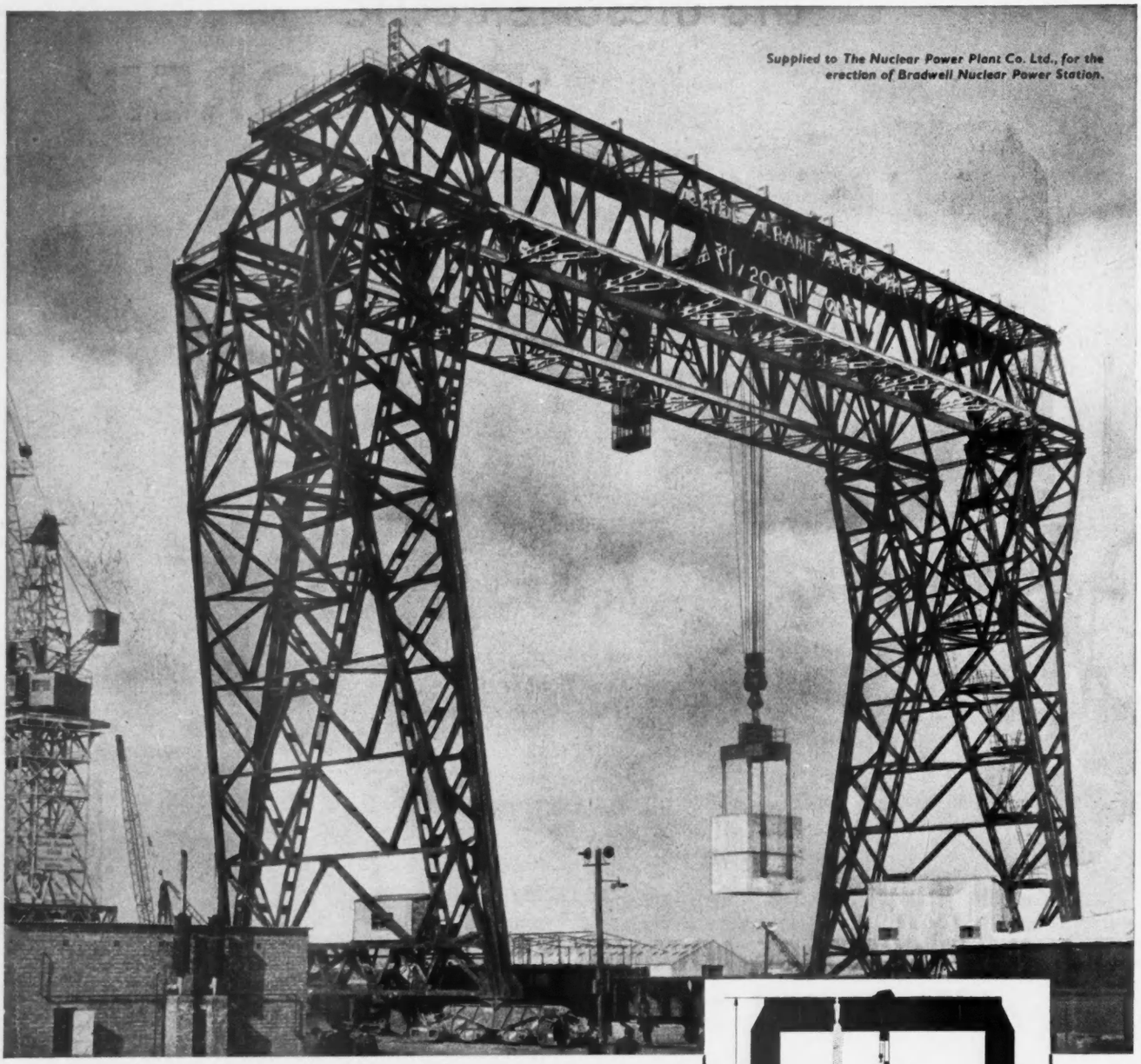

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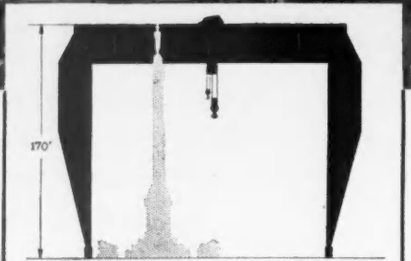

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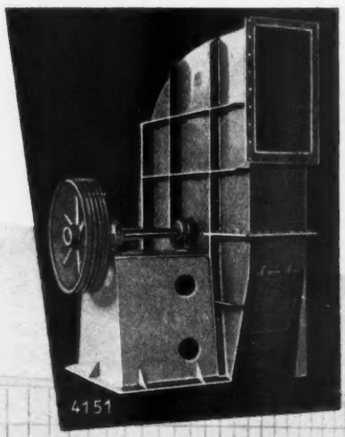

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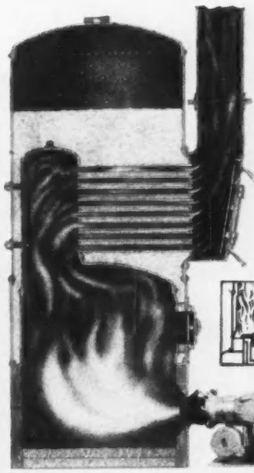

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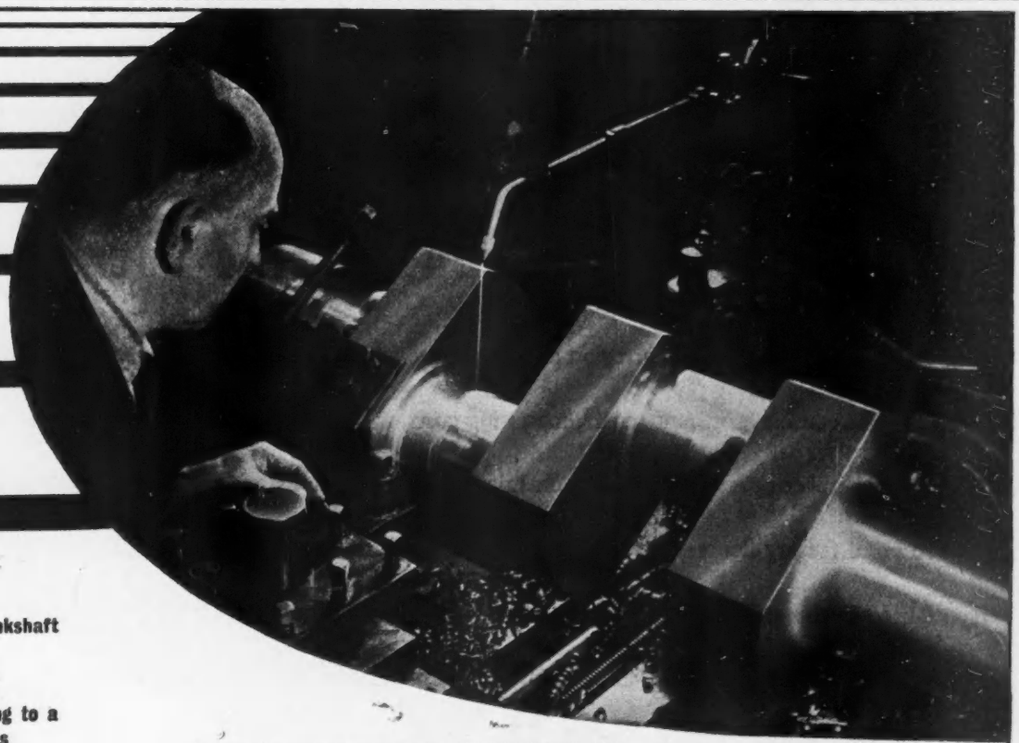

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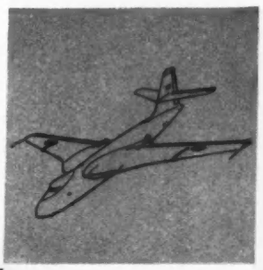

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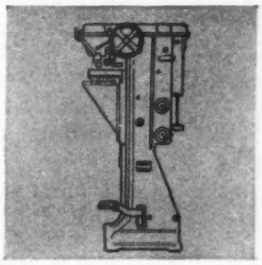

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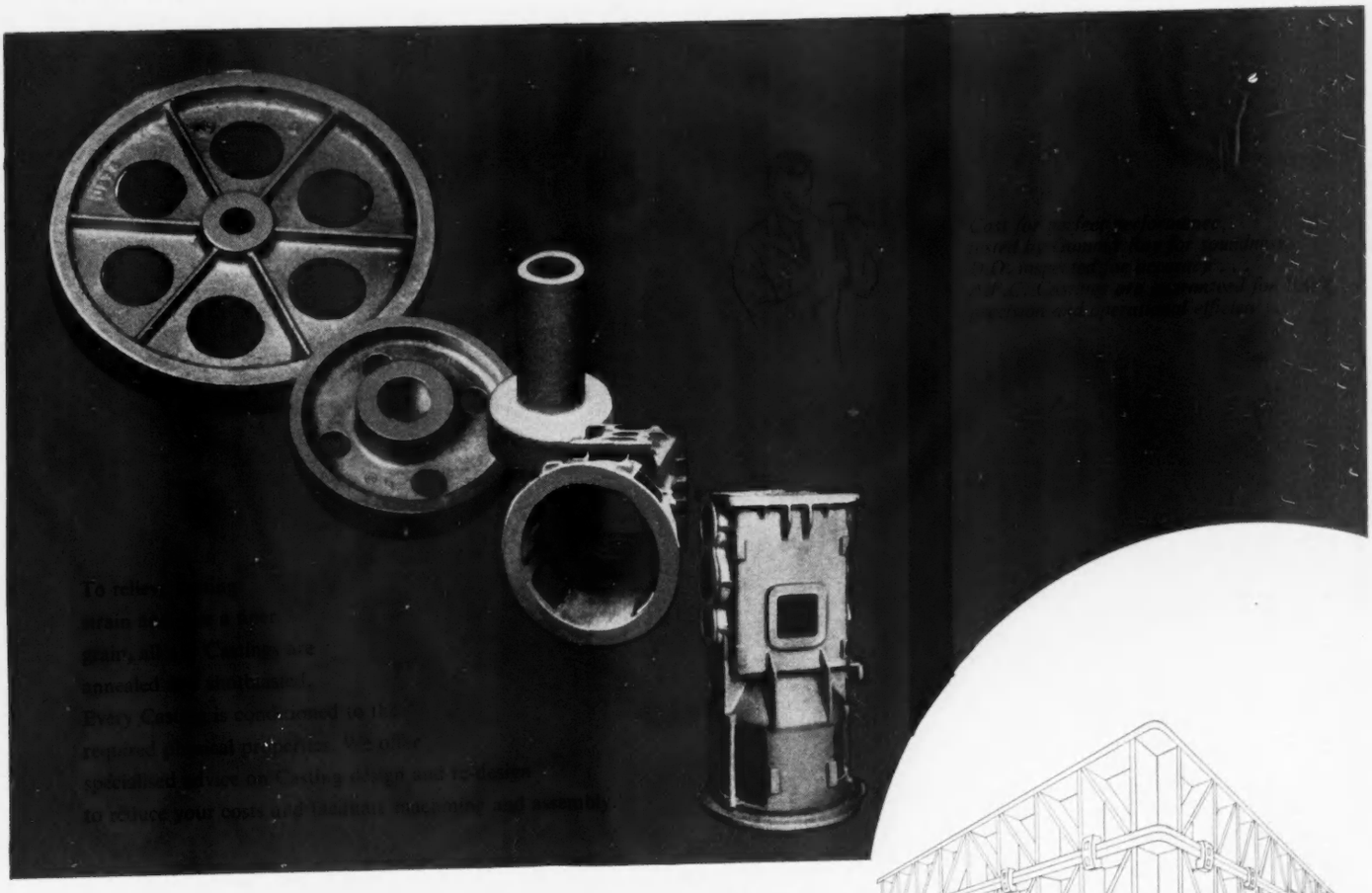

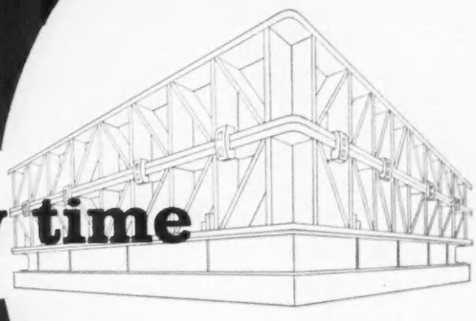

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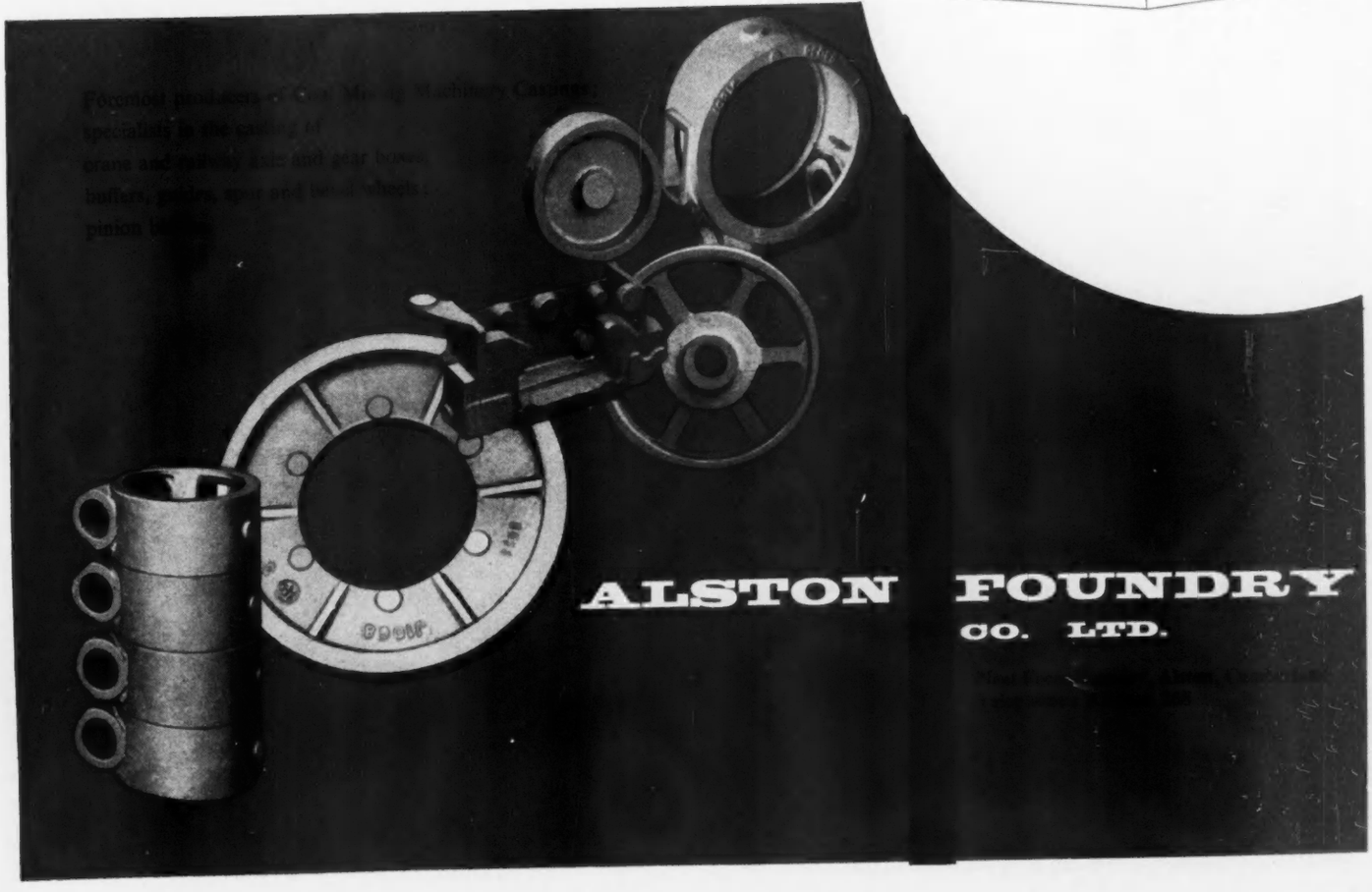

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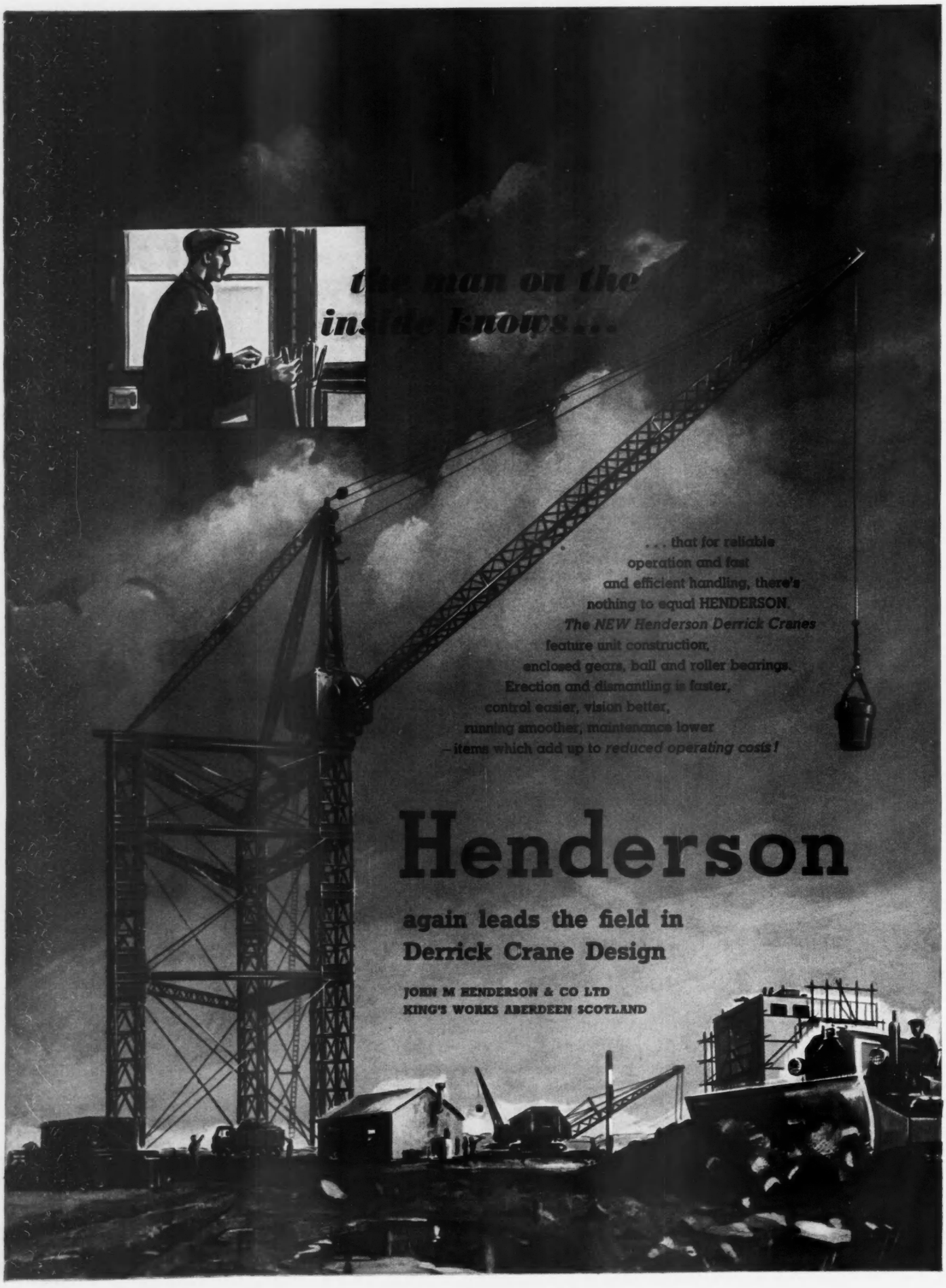
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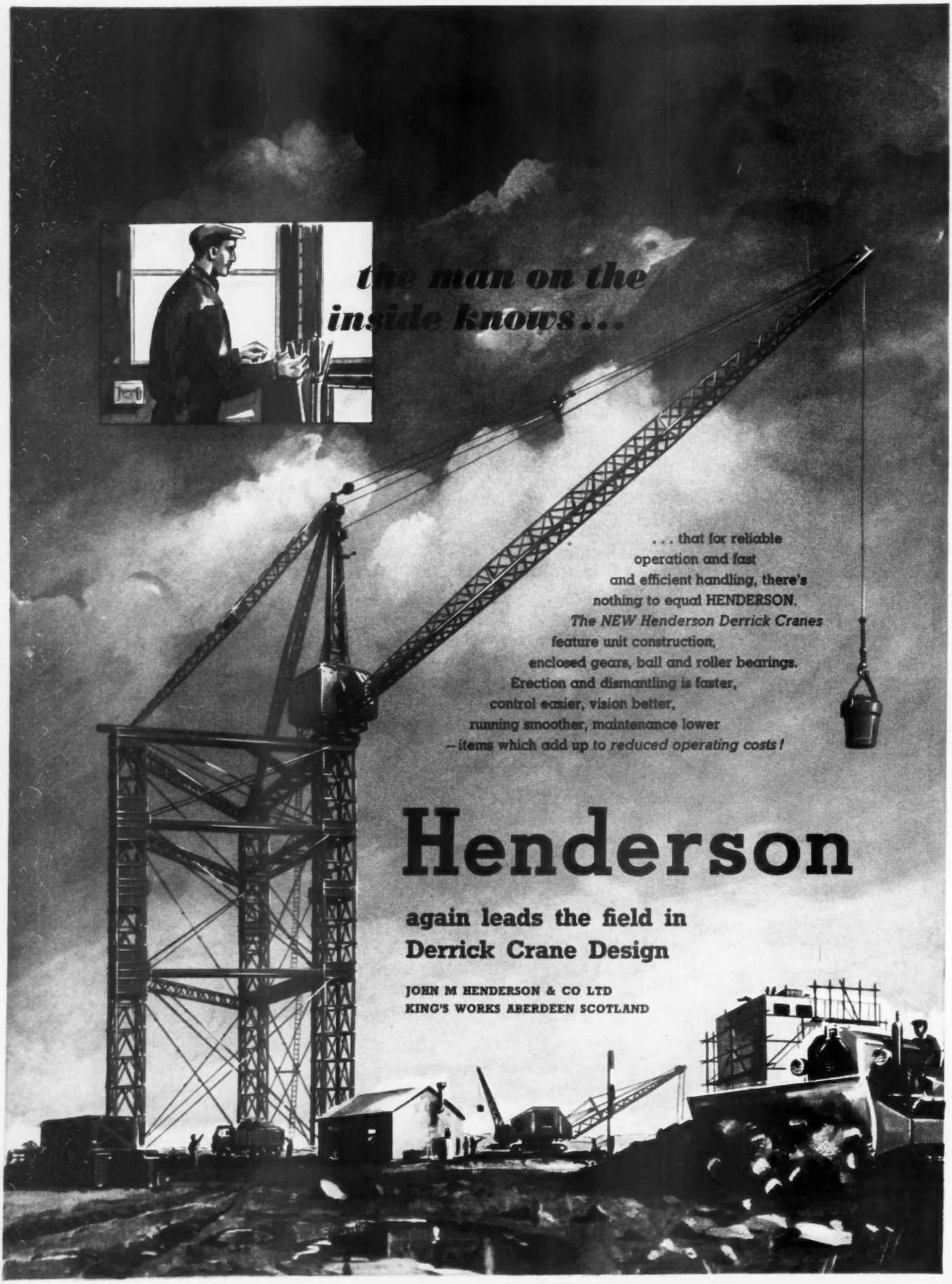
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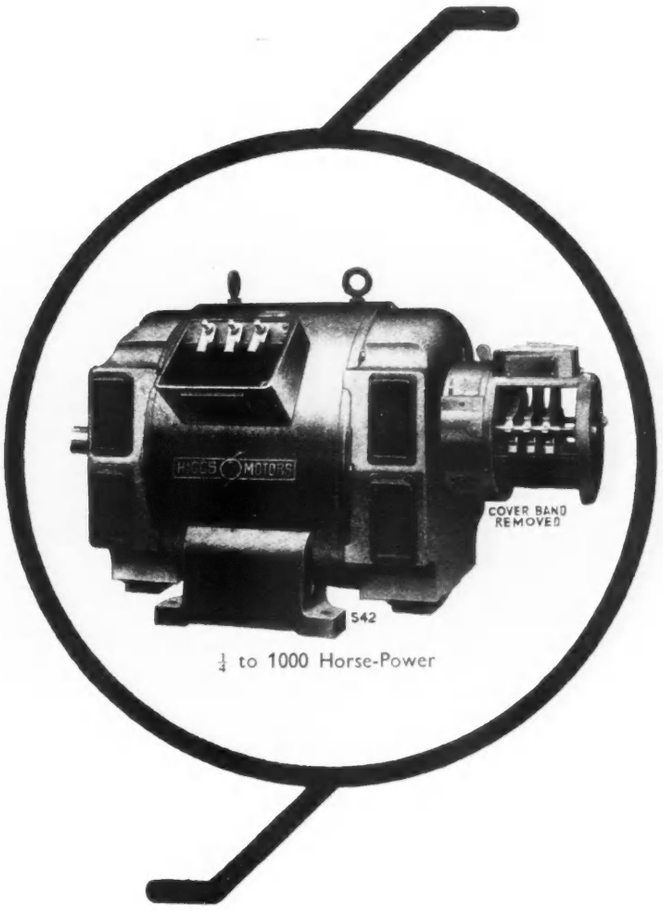

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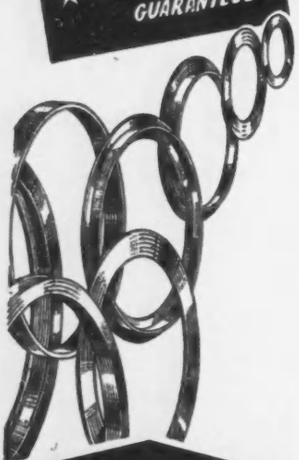

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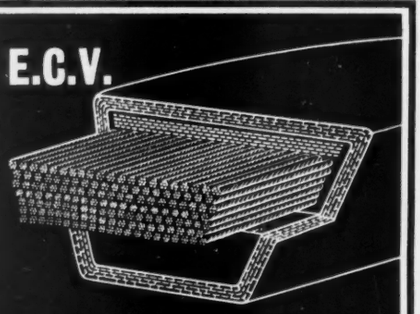

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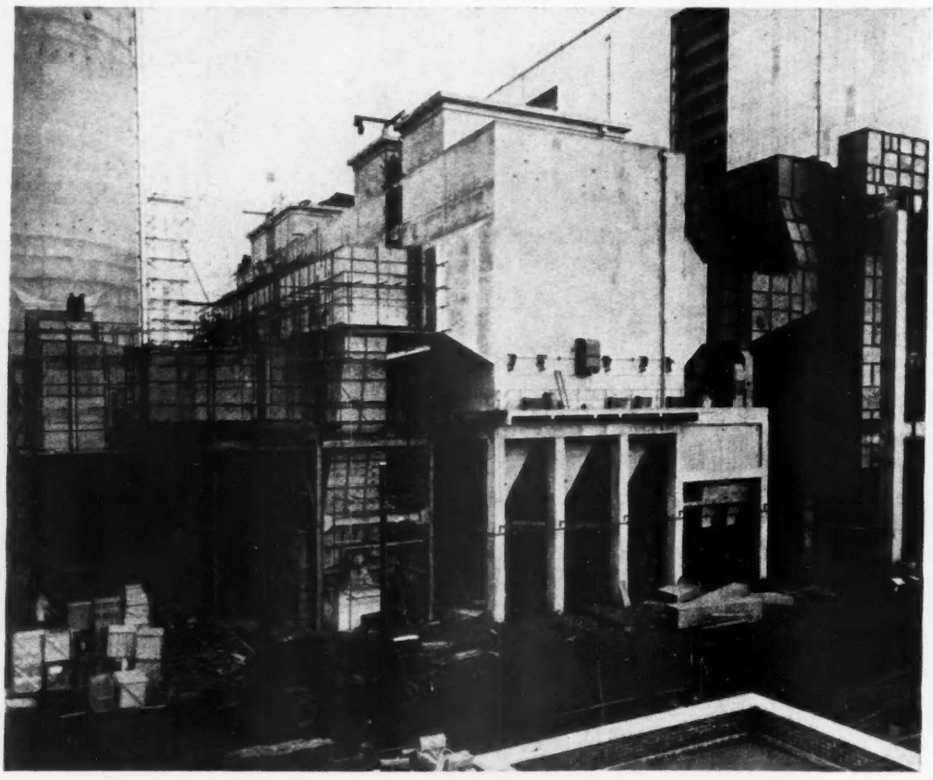

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THE ENGINEER

No. 5381 MARCH 13, 1959 VOL. 207

HEAVY-OIL ENGINE WORKING COSTS AND PERFORMANCE

There is a familiar passage in " Othello " where the Duke, after telling Brabantio that : " Men do their broken weapons rather use Than their bare hands," goes on to remark how : " To mourn a mischief that is past and gone Is the next way to draw new mischief on." While the Duke was alluding to mental rather than mechanical mischief, the user of diesel engines is not likely to " draw new mischief " in the way mentioned by the Duke. The engine user is nevertheless preoccupied by the constant need to keep clear of mischief and in this he finds much to aid him in the experiences of other users, such experiences, for example, as are related in the *Report on Heavy-Oil Engine Working Costs and Performance* compiled annually by the Diesel Engineers and Users Association and presented (for the year 1957–58) on December 18, 1958. In this report attention is called to the increasing importance of the performance section, and in introducing the current report Mr. W. Howes deals most realistically with that section wherein, under the heading : " Notes and Comments," Members of the Association, giving unvarnished details of mischiefs which they have encountered, seek not only the comments and suggestions of other members but, by disclosing their own experiences, afford advice and warnings calculated to prove valuable to engine users and engine makers alike. The " Notes and Comments " printed in the present report occupy as many as fourteen pages relating to installations affording wide variety in type, size and service and operating not only in Great Britain but in many other parts of the world. Reading these comments—perhaps the only thing possessed by them in common is that they all relate to land installations—it would appear easier to avoid mischief at sea than on shore, since according to the late Mr. John Lamb (*The Running and Maintenance of the Marine Diesel Engine*) " If a well-established make of engine gives trouble or is costly to keep in order, the cause in ninety-nine cases in every 100 is improper handling." It must be remembered, of course, that the marine diesel engine is normally operating for long periods without stops, starts or fluctuations in load, these being circumstances which very rarely apply to land installations.

In his introduction Mr. Howes has mentioned that " for forty-five years the particular objective of the D.E.U.A. has been that of providing a means whereby co-operation among members might be used to disseminate the information accumulated for a better understanding of the operating problems of diesel engines, and by this to inform designers and builders of the experiences and difficulties of users." Scrutiny of the " Notes and Comments " discloses—among other things—how big end bearing failures continue to take place due to excessive clearance between crankpin and bearing, a type of mischief which can hardly be charged to design or to materials. On the other hand, it seems astonishing that tie-bolt failures should still be taking place due to the machining of " dimples " on bolts subjected to heavy and fluctuating stresses, breakages for which there can be no excuse. Here and there in the " Notes and Comments " we find information and suggestions of high practical significance, though many of them echo suggestions which, made previously, have fallen, apparently on deaf ears. Surely the time is past when an engine buyer makes his choice of engine on the basis of test bed performance and/or price rather than on detailed scrutiny of the design and careful checking of the available operational experience. One user suggests that " the Association from its records, might compile a list of undesirable features and happenings, so that an intending customer could assure himself of reliability and the best design of engine for his purpose." A difficulty is that with so many potential uses and a demand in each category which may justify quantity production, the engine manufacturer, pressed by ever-growing competition, endeavours to develop and popularise a design with which it is hoped to cover a plurality of duties. Engines are required for driving electric generators, air compressors, pumps, rail vehicles, road vehicles, earth-moving equipment, hoists, well-drilling equipment, farm mechanisation appliances, &c., services calling for a great variety of outputs and speeds and operating under widely differing conditions as regards maintenance, effect of involuntary stoppages, &c.

All users of oil engines have to keep in mind some degree of uncertainty with regard to the price, specification and indeed to the long term availability of fuel oil. They must also consider the effect of ever increasing cost and difficulty in obtaining skilled maintenance men, circumstances which prompt the selection of the engines deemed most likely to give trouble-free operation over long periods. The fact that engines are available which produce large power on small dimensions and weight is no argument for their use in conditions where the imperative need is for reliable long-term operation rather than minimum weight and bulk. Moreover, in the face of those unpredictable political and industrial conditions which can influence the availability, cost and specification of fuel oil, the engine user will wish to protect himself by installing engines wherein adverse changes in the digestibility of the fuel will have minimum effect on reliability and maintenance cost.

ATMOSPHERIC POLLUTION

Over the next ten years or so, supposing the Clean Air Act to have its expected consequences, there ought to be substantial reduction of the pollution of the atmosphere by smoke and grit. But unless there are adequate means of measuring the pollution it may not be possible to show what benefits the Act has conferred upon this country. It is therefore gratifying to note from a D.S.I.R. report on the *Investigation of Atmospheric Pollution** during the year ended March 31, 1957 (only just published now almost two years later !) that during 1956–57 the number

* H.M. Stationery Office, 7s. 6d. net.

of bodies co-operating in making systematic measurements of air pollution rose by 351. On March 31, 1957, there were 2441 instruments in use, 328 new ones having come into operation during the year. No doubt the expansion in the number of instruments in use has continued steadily since. We certainly hope so. Many of the new instruments have been installed for measuring deposited matter. But some also are intended for the measurement of sulphur dioxide. There is undoubtedly room for a very large increase in the number of instruments and the report of the Director of Fuel Research, included in the volume, draws attention to the fact that "in several regions containing 'black areas' instruments for the determination, particularly of smoke, are relatively few." We hope that situation has been to some extent corrected since the report was written.

Under the influence of the Clean Air Act, pollution of the atmosphere by smoke and grit should certainly be reduced. But, as has frequently been pointed out, controlling emissions of smoke does not necessarily have any influence upon the amount of sulphur dioxide poured into the atmosphere, and it is the sulphur dioxide which is responsible for much of the damage done to buildings and other structures. Substantial attention continues to be given to researches relating to sulphur dioxide. We note from the report, for example, the making of studies of the distribution of sulphur dioxide from the chimneys of a new power station, and interest being taken in measurements which showed a marked increase in the soluble sulphates present in the air under "smog" conditions. The Central Electricity Generating Board has proved helpful and has developed special instruments suitable for measuring sulphur dioxide in the atmosphere which are being made commercially. Still on the subject of sulphur, we note that research continued into gas-washing processes, particularly one in which water containing manganese dioxide in suspension is used as the medium. One of the troubles with this process—otherwise satisfactory—appears to be that the sulphuric acid produced is not sufficiently pure to be saleable.

A note in the report states that on the recent closing down of the Fuel Research Station work on air pollution research was transferred to the Warren Spring Laboratory of the D.S.I.R. It would certainly have been a very undesirable consequence of the closing of the former laboratory had its work on atmospheric pollution come to an end.

FIRST GENERAL-PURPOSE FRIGATE LAUNCHED

When the naval rearmament programme began in 1951, Britain concentrated on modernising many of her existing warships, reconstructing and completing her aircraft carriers and cruisers laid down during the war and on building a large number of small, fast vessels to deal with the menace from mines and modern submarines and aircraft. The small-ship building programme includes no fewer than 250 minesweepers of an entirely new type for sweeping magnetic, acoustic and other influence mines, the conversion of thirty-three of our older destroyers to fast frigates, and the construction of forty-four new fast frigates. Five of the new frigates were designed primarily for the direction of carrier-borne and shore-based aircraft ; four, with a heavy gun armament of 4·5in A/A guns, to provide anti-aircraft defence for convoys ; and twenty-eight as anti-submarine escorts. The remaining seven are called "Tribal" class frigates. We give some particulars of the first of them to be launched, the "Ashanti," on another page. They were authorised in the 1955–56 Estimates and are general-purpose vessels, designed to carry out the three main escort functions of anti-submarine protection, anti-aircraft defence and aircraft direction. There are, also, according to *Jane's Fighting Ships*, fourteen post-war designed submarines built or building. All these ships are a great improvement on the wartime ships of similar types. But they have power plants and armaments which were designed before the advent of nuclear propulsion and guided missiles. If the Royal Navy is to play its part in the event of a major war, it is now surely becoming imperative to build modern ships with nuclear power plants and guided missile armaments. Britain now shares atomic secrets with the Americans and has at last produced a first-rate naval guided missile. Yet she is still only preparing to lay down her one and only nuclear-propelled submarine and the four destroyers with a guided missile anti-aircraft armament which were all authorised as long as three or four years ago. It was therefore with relief that we heard it announced in Parliament last Monday that special priority is to be given to the construction of the nuclear submarine, the "Dreadnought." For it seems to us high time that the Navy began to get experience with a kind of propulsion plant likely quite soon to be adopted for all new naval vessels except the smallest.

EXPORTING IDEAS

We have been studying the text of a speech which was delivered last week at the annual meeting of the British Employers' Confederation, by Sir William Garrett, the president. He emphasised the need for British industry to "keep steady" those of its costs over which it had internal control. That would be essential, Sir William commented, even if this country was faced with no keener competition than hitherto in its overseas markets. But, he added, all the signs were that this country would have to fight even more keenly to retain its present proportion of world trade in the face of the big changes, technical, political and economic, which were taking place on a world-wide scale. Those changes, Sir William urged, should be accepted as a challenge and an opportunity. He went on to talk about the requirements of developing countries overseas, "particularly in regard to capital equipment and to the newer products of technical invention." From there, Sir William went on to point out how desirable it was that Britain should furnish all the technical help that it could to under-developed countries overseas. The suggestion that this country should lose no opportunity to export its ideas is, of course, not a new one ; it is one which engineers particularly have been carrying out in various ways for years. In emphasising the suggestion again, however, Sir William Garrett has directed attention to another matter closely concerned with the export of ideas. In his speech he put forward the view that if this country is able to establish and maintain "healthy industrial relationships," those countries which are now developing an industrial life of their own are much more likely to seek advice and guidance here, "not only in the field of industrial relationships but also in the field of technical development."

Anxiety is frequently expressed about the present and possible future trend of industrial relations in this country. Statistics about the number of working days lost annually through unofficial strikes and reports of irritating demarcation and other disputes that have to be made all too often can quickly cast a shadow over the real state of

Britain's industrial relations. Possibly not enough is said about the numerous examples of satisfactory relations that can be found throughout the country. But both sides of British industry have a dual opportunity here. They can see to it that the generally prevailing high standard of industrial relationships is maintained ; they need not then be reluctant to export ideas on a subject which must be of considerable importance to those countries which are now engaged on the development of their industrial life. As Mark Tapley would put it, the prospects for achieving success in this sphere may, after all, be " uncommon bright."

THE TRAFFIC ENGINEER

The practice of traffic engineering, and the establishment of courses for qualification in that subject, have had rather an uncertain and faltering growth in this country. By contrast, the traffic engineer has become well established in the United States, and is becoming so on the Continent. However, it is impossible to deny that though strictly a specialist, the traffic engineer has an important function in planning for contemporary transport. Last week, the Institution of Civil Engineers held a supplementary meeting to discuss traffic engineering, and to find out from those who spoke whether they considered that any special provision by the Institution was needed to encourage the subject, and whether practical training in traffic engineering should be recognised as the equivalent of practical training on works as one of the basic qualifications for corporate membership. There was quite a degree of divergence of views in the opinions expressed at the meeting. That, in itself, however, is not important, for it was evident that, although the exact details of what should be done were debatable, the general desire was that the subject should be actively encouraged, and that the Institution should take a lead in encouraging it.

The Institution's position is not a simple one, for traffic engineering is not entirely an engineering subject, and certain aspects of it are successfully practised by men who are not qualified as civil engineers, but whose active contribution would help to make any forum of the Institution's comprehensive. This sort of situation is likely to be met again and again in the future, as the world of engineering becomes more specialised. It is far better that the major Institutions should learn to provide for the specialised as well as the general interests, than that more " splinter groups " or minor Institutions should spring up to cater for new and specialised subjects. Traffic engineering is, again, a good example of how a new subject is likely to cut across the relatively well-defined boundaries of the more traditional subjects, for it covers not only the study of the geometrical design of roads and the control of road traffic, but also the interplay of one form of transport on another, and studies such as those of passenger and traffic flow on railways and underground lines. Apparently British research papers on traffic engineering are plentiful and of good quality, but there are few British papers about practical applications. The Institution's most promising contribution would appear to be that of fostering the latter group, and of setting examination standards which would encourage the teaching of traffic engineering at universities and subsequent practical work in the subject.

A TWENTIETH CENTURY CITY CENTRE

A modern city needs motor roads to serve it, and its plan should be adapted to suit motor traffic. The motor roads should be the skeleton, with the car parks, the pedestrian enclaves, the minor roads and the great buildings grouped around them like the organs and flesh which clothe the living skeleton. The roads are the job of civil engineers; the rest of the plan is not, in many respects, a responsibility of engineers. These views we have expressed consistently in these columns. An example of the same point of view, as expressed by a group of architects, now comes to our notice. It relates to a plan—an unofficial plan—for the centre of Bristol, and will be shown at an exhibition at Bristol next week. We have not seen the plan in detail, but, nevertheless, think it worth while to enumerate its aims, which seem to express so well the planning problem of the twentieth century city centre. They are as follows.

(*a*) To reshape the heart of the city to do its economic, social and cultural work efficiently in the foreseeable conditions of the future. (*b*) To separate the circulatory systems for pedestrians and motor traffic in selected areas and to allow both to develop independently ; to provide in phases for increase of traffic by about 200 per cent. (*c*) To provide for about 8000 cars in multi-level car parks near the centre. (*d*) To provide a central pedestrian concourse above the present traffic centre. (*e*) To provide pedestrian precincts by the Cathedral, Council House and university and link them with pedestrian routes to the central " piazza " or square. (*f*) To show the sort of high-density building that could be supported by an improved system of circulation in the central areas. (*g*) To show this to be a better form of growth than encroachment into the countryside. The proposals are limited to selected parts of an area within about 400 yards of the main traffic centre, where there are large areas of bomb-damaged and dilapidated buildings ; demolition is limited to obsolete buildings. This area will be shown as a model at the exhibition.

The Engineer—100 Years Ago (MARCH 11, 1859)

" LORD STAFFORD'S STEAM CARRIAGE "

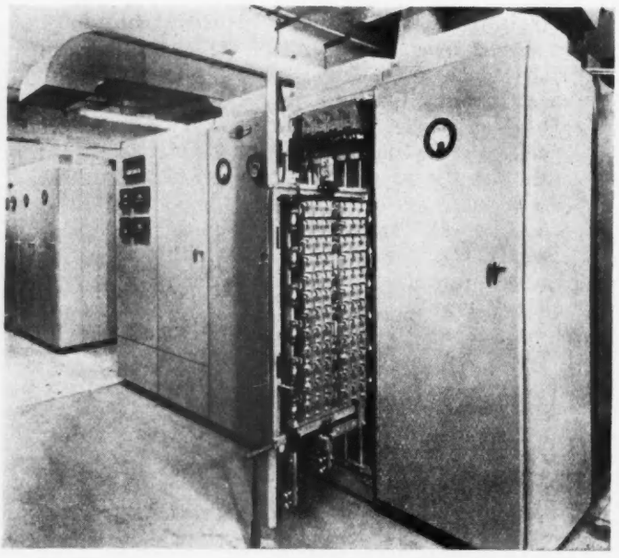
" On Monday last, Lord Stafford and party, comprising Lord Vane, Lord Sefton, and Mr. Ellice, made another trip with the little engine from Buckingham to Wolverton. His lordship drove and steered ; and although the roads, from constant rain, were very heavy, they were not more than an hour in running the nine miles to Mr. McConnell's residence, Old Wolverton, exclusive of stoppages. This is now the third trip the engine has made from Buckingham to Wolverton and back, twenty miles, besides other runs. His lordship and Mr. McConnell have both repeatedly admitted that it is guided with the greatest ease and precision ; in fact, Lord Sefton, who had not travelled with the engine before, drove it several miles on this occasion. It runs easy, being mounted on springs, and quiet, excepting the roar of steam from the blast-pipe ; and as this can be shut off at will, but little difficulty has yet been experienced in meeting horses.

" The engine is of 3 horsepower, having a pair of 3-in. cylinders, 9-in. stroke, worked to 110 lb. pressure, 3-ft. driving wheels, geared by a fine pitched chain on one side ; velocity of load 2·5 to piston 1. It has a flue and tubular boiler, giving 31 ft. of heating surface. The frame is formed of two tanks, containing forty-two gallons of water. The front wheel is placed between them at one end, the other end forming a coal store, with boiler above ; an ample seat for three is provided in front, quite distinct from the engine—the crank shaft etc, being underneath the chimney, is at the back end as far from the passengers as it can be—and a seat for the stoker also. Its weight is 19 cwt. 2 qrs., which mounts up to 30 cwt., with full load of passengers, water, and coal ; it consumes 6 lb. to 7 lb. of coal per mile, and evaporates one gallon of water per minute. It was designed by the maker, Mr. Rickett, to run at a speed of ten miles per hour ; one mile in five minutes has been observed, though a higher speed has been attained, at which it is perfectly steady, the centre of gravity being not more than 2 ft. from the ground."

Semi-Conductor Rectifiers for High-Power Electro-Chemical Duty

By P. S. CLAYTON, B.Sc., A.M.I.E.E.* and
G. E. SNAZELL, B.Sc.*

A large chlorine plant supplied entirely by germanium rectifiers was recently put into operation at the Ellesmere Port works of the Associated Ethyl Company, Ltd. We give some details of this 18·4MW, 80,000A installation, and review some developments of this form of conversion equipment undertaken by the British Thomson-Houston Company, Ltd., and their application in the field of electro-chemical engineering.



ALTHOUGH semi-conductor rectifiers can be utilised for almost any a.c.-d.c. conversion application, their characteristics of reliability, high efficiency, compactness and simplicity of operation make them particularly suitable for electro-chemical duty. This covers a wide range of heavy current continuous duty applications using d.c. power at low and medium voltages. Typical applications for which semi-conductor rectifiers have been supplied are water electrolysis

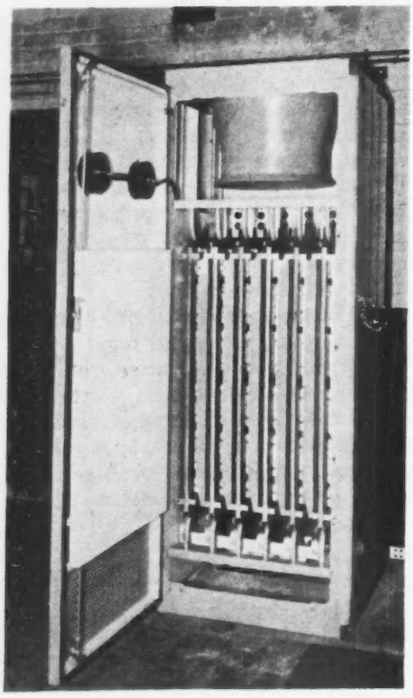


Fig. 1—300kW germanium rectifier installed in December, 1953

at 275V, chlorine production at 230V, and copper refining at 100V. A further interesting application, which is not strictly of a continuous nature, is in the steel industry, where germanium rectifiers are in operation supplying direct current at below 25V for the electrolytic cleaning and tin plating of steel strip.

The first medium-voltage germanium power rectifier to go into commercial operation was commissioned at B.T.H. Rugby Works in 1953, and since that date a large number of germanium rectifiers have been manufactured by B.T.H. for various applications and installed in many parts of the world. It is interesting to note that two of the early B.T.H. germanium power rectifiers were for electrolytic applications and both replaced other forms of converting equipment. The first, rated at 300kW, 1100A, 275V, is shown in Fig. 1. This rectifier, which replaced a grid-controlled glass bulb rectifier, was installed in December, 1953, and supplies a small electrolysis plant producing hydrogen and oxygen in the B.T.H. works at Rugby. The second equipment, rated at 1000kW, 3920A, 255V, was supplied by B.T.H. to I.C.I. in 1955 and operates in parallel with a number of rotary converters supplying chlorine cell lines. Fig. 3 shows the germanium rectifier installed adjacent to the rotary converter it replaced and illustrates the saving in space that can be effected with semi-conductor rectifiers. Although the rectifier has the same rating as the rotary converter, it occupies substantially less floor area and is situated at the side of the machine room as a crane is not required for maintenance work.

Both of these germanium rectifiers make use of the existing transformers and switchgear. For load control the first equipment utilises the existing transformer off-load taps to give stepped control, and the second equipment makes use of the induction regulator originally supplied with the converter, to provide continuous control.

Typical efficiency curves for the various types of conversion equipment available in Britain are shown in Fig. 2. It will be noticed that a big improvement in efficiency was made possible by the advent of the mechanical contact rectifier, which was developed on the Continent during the last war and subsequently in England by B.T.H. The contact rectifier, however, has a number of operational disadvantages by comparison with semi-conductor rectifiers, which are simple in operation and require no specialised maintenance. The germanium rectifier is also practically insensitive to distortion or dips of the a.c. supply voltage, and it operates at overall efficiencies as high as, and sometimes higher than, the contact rectifier.

With the rapid progress still being made in the design and production of semi-conductor cells, the permissible working voltage of individual cells is still increasing. This means that fewer cells need be connected in series for a given output voltage, and an even higher rectifier efficiency is thus obtained.

Before describing the 18,400kW, 80,000A installation for the Ellesmere Port works of the Associated Ethyl Company, Ltd., a brief

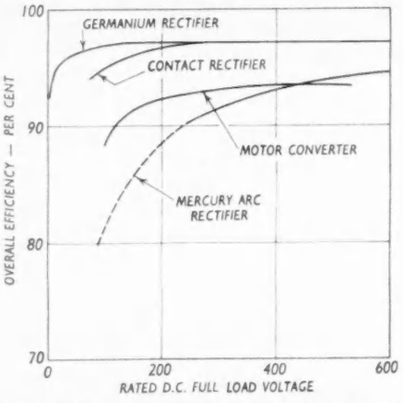


Fig. 2—Efficiency characteristics of various kinds of conversion equipments for 15,000A, d.c. rating

description of the germanium rectifier itself and of the electrolytic process may be of interest.

Semi-Conductor Rectifier Manufacture

The early germanium power rectifiers were built using germanium large-area fused-junction cells produced under laboratory conditions in a pre-production unit set up by the B.T.H. Research Laboratory. The transfer of this work in 1956 to a mass production factory† presented many more problems than are involved with the transfer of more conventional products. The difficulties which had to be overcome in solving some of these problems are well illustrated by the fact that the degree of impurity of the semi-conductor material has to be reduced to less than one part in one thousand million.

To meet the exacting requirements of semi-conductor rectifier development and manufacture B.T.H. designed and constructed a new factory which incorporated many innovations. The building is both temperature and humidity-controlled throughout and every care is taken to avoid the ingress of dust and dirt. In addition to these precautions some of the more critical operations are

* A.E.I., Heavy Plant Division.

† Described in THE ENGINEER, March 7, 1958, page 361.

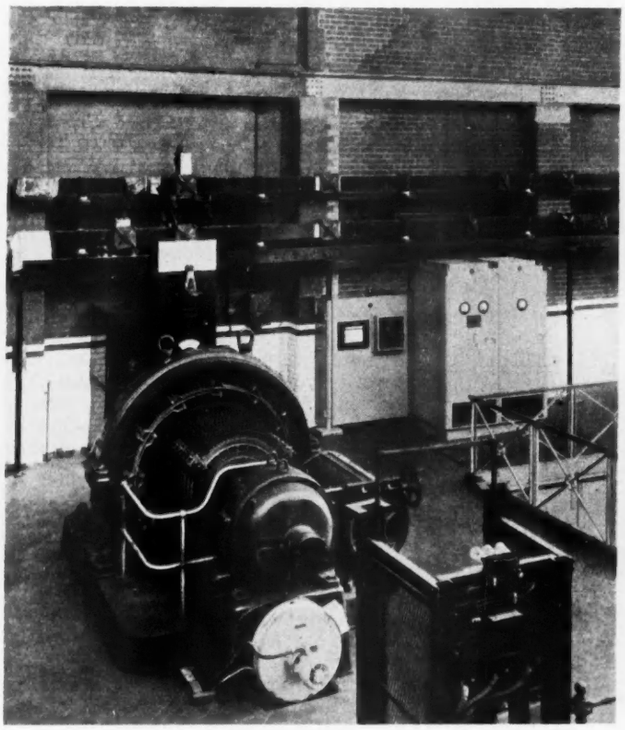


Fig. 3—1000kW germanium rectifier operating in parallel with rotary converters

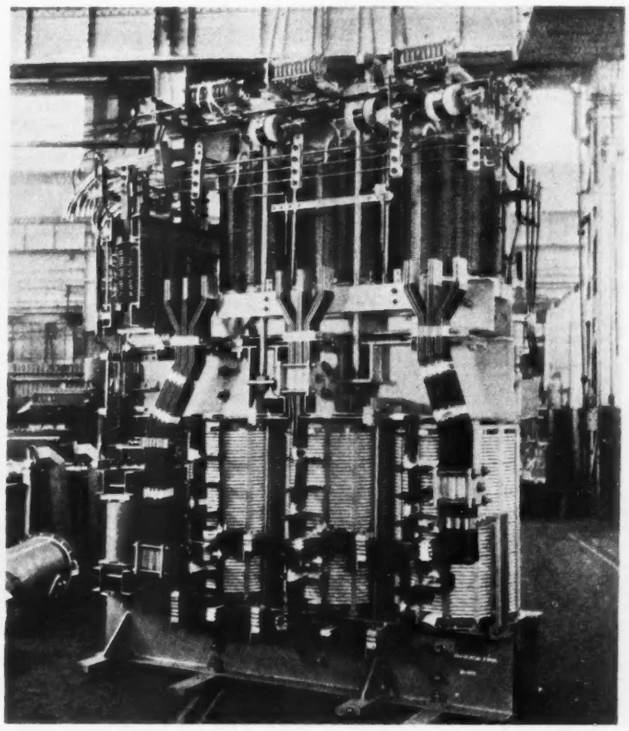


Fig. 4—Assembled core and coils of the regulating and rectifier transformers

carried out in cabinets separately fed under pressure with dry filtered air.‡ Throughout manufacture, materials are subjected to chemical, optical and electrical measurements necessary to establish the high degree of control essential for the mass production of rectifier cells with predetermined and consistent characteristics.

The general construction of the rectifier cells used in the equipment for the Associated Ethyl Company, Ltd., is shown in Fig. 5.

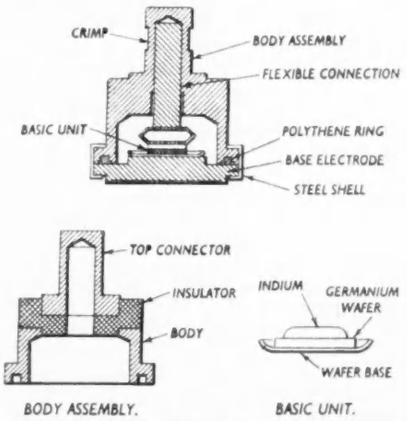


Fig. 5—General construction of a germanium cell

A cell may be regarded as consisting of three sub-assemblies : the rectifier itself, the electrodes to which the electrical connections are made, and the body which completely encloses the rectifier. The rectifier sub-assembly comprises a metal base, a thin wafer of monocrystalline germanium soldered to the base, and a pellet of indium alloyed into the upper surface of the germanium. Rectification takes place inside the germanium slice at the interface dividing the original unchanged crystal from the indium alloyed portion.

The electrodes consist of a flexible copper strip soldered to the indium pellet and a solid copper block soldered to the metal cell base. The flexible connection prevents variations of mechanical pressure on the rectifier assembly, and the solid base permits heat generated within the cell to be readily conducted to the cooling fin. The basic rectifier unit and its electrodes are fitted into a body assembly hermetically sealed by a polythene ring which is compressed between the body and the base electrode by a steel shell peened over under pressure. The top terminal is crimped about a solid copper stem attached to the flexible connection, to give a good permanent electrical contact.

The rectifier cells are mounted on short lengths of extruded aluminium cooling fins by means of a clamping plate and four self-tapping screws. The surface of the fin is carefully de-oxidised and then greased to ensure a good electrical joint between the cadmium plated cell base and the aluminium fin, which will not deteriorate. Connection from the fin to the next cell or copper bar is made by a flexible tinned copper connector with a " Cupal " tag spot-welded to the fin. In this manner, the most suitable metals for both the cell base and fin can be used, while all copper-to-aluminium joints are protected against corrosive attack.

The rectifiers are forced air-cooled by a quiet running fan driven by a squirrel-cage motor mounted in the top of each cubicle. Air cooling in preference to direct water cooling was chosen as being the most reliable method for rectifiers which are required to operate continuously twenty-four hours a day and possibly 365 days a year. This method of cooling is in line with the change to air cooling which took place in the mercury arc rectifier field in Britain about twenty years ago.

Chlorine Manufacture

The manufacture of chlorine and caustic soda is an important basic industry for which the electrical power demand has increased enormously in recent years. Nowadays manufacture is generally by the electrolysis of brine in either a diaphragm cell or a mercury amalgam type of cell, the type and size of cell chosen for a particular plant being largely decided by economic factors.

In the equipment described, two lines of 30,000A mercury amalgam cells are used to manufacture chlorine, caustic soda and hydrogen. The basic principle on which the cells operate is the preferential deposition of elemental sodium rather than hydrogen at the cathode. This occurs for two reasons :

(*a*) hydrogen has a higher electro-chemical voltage with respect to the mercury cathode than has sodium.

(*b*) sodium is readily soluble in mercury, forming a sodium-mercury amalgam.

When mercury and a saturated solution of brine are fed into one end of the electrolyser and pass between the electrodes, chlorine is liberated at the anodes and sodium dissolves into the mercury. At the far end of the cell the spent brine and chlorine are drawn off and the mercury amalgam is ducted into the decomposer. Water is fed into this second chamber in contra-flow to the amalgam, with the result that hydrogen and sodium hydroxide solution are produced whilst the regenerated mercury is pumped back into the electrolyser.

The operation of " wet " cell lines of this type at high d.c. voltage can introduce electrical leakage problems in the cell hall, and for this reason it is often recommended that the voltage be limited to about 250V, d.c., which limits the number of cells connected in series to between fifty and eighty depending on the type of cell used. In the equipment at Ellesmere Port the individual cell voltage varies between 3·9V and 4·2V according to the lifetime and state of the anodes.

Rectifier Equipment at Ellesmere Port

The two cell lines at Ellesmere Port are separately fed with power at 230V d.c. by 24-phase rectifier equipments, each rated at 40,000A. The first line was put into operation in February, 1958, and the second line

‡ loc. cit.

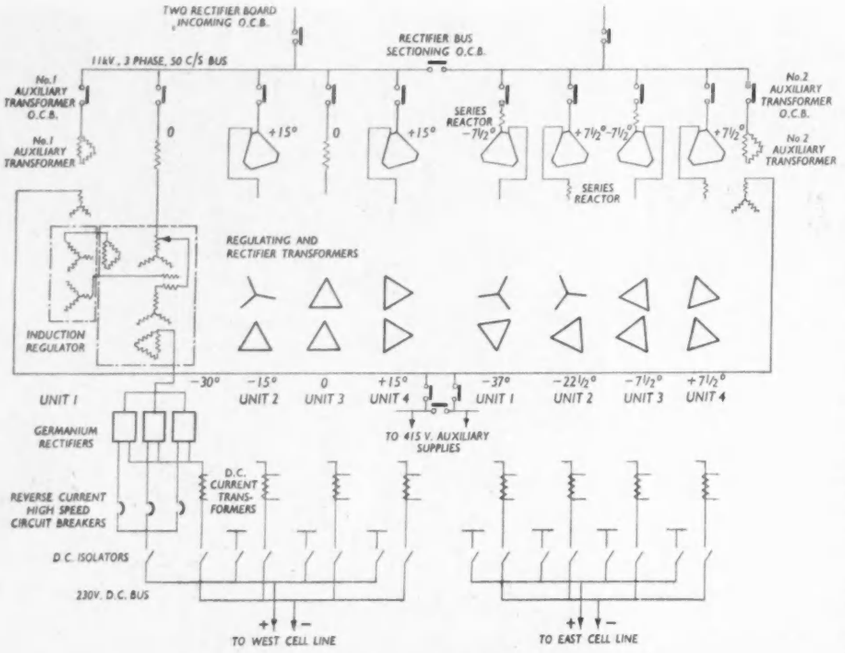


Fig. 6—Main power circuit of the rectifier equipment

commissioned three months later. The rectifier plant is believed to be the largest semi-conductor rectifier installation operating outside the U.S.A.

Complete electrical separation of the two cell lines enables the cell currents to be adjusted independently, and provides flexibility of operation. This arrangement also permits automatic control of the cell line current during normal steady running conditions. Regulating transformers equipped with on-load tappings give the necessary voltage and current control over the working range.

The output voltage of mercury arc rectifiers is usually varied between transformer tappings by grid control—that is, by controlling the instant in every cycle at which the anodes fire. With semi-conductor power rectifiers this is not yet possible, and the method used on this equipment is to employ an induction regulator feeding a series boost transformer. The stator of the regulator is excited from a tertiary winding on the main regulating transformer, and the rotor output feeds a boost transformer in each main rectifier transformer tank. As the regulator rotor is rotated by its driving motor, so the output voltage is shifted in phase with respect to the supply.

Power is supplied to the factory from two 33/11kV, 12·5MVA transformers, each equipped with seven-position, on-load tap changers controlled in unison from the main rectifier control room.

Four separate three-phase, bridge-connected rectifier units make up each rectifier equipment and are supplied through an 11kV B.T.H. switchboard, as shown in the main power circuit diagram reproduced in Fig. 6. Each unit comprises a phase-shift transformer or reactor, a separate regulating transformer, a rectifier transformer, an induction regulator, three germanium rectifier cubicles, three d.c. circuit breakers and the associated unit control gear. The main transformer tank for each unit houses the regulating transformer, a star-connected auto-transformer with seventeen-position, on-load, tap-change gear, a series boost transformer, and a double-wound rectifier transformer. The compact arrangement of these transformers in one tank is illustrated by Fig. 4.

The phase-shift transformers and the primary windings on the rectifier transformers are designed so that the four units forming one equipment work together twenty-four-phase, and when both cell lines are operating forty-eight-phase overall working is achieved. To ensure that all units share the load current equally, the total reactance of the various units has been matched to obtain the same inherent regulation. This has been achieved by adding series reactors to the units requiring no phase-shift transformer, and small reactors to the 7½ deg. phase-shift transformers.

The plant is designed to operate continuously with an annual load factor of 95 per cent or higher, and any prolonged interruption of the d.c. supply, besides reducing chlorine production, also has an adverse effect on the life and operating efficiency of the mercury cells. Continuity of d.c. supply is therefore an essential requirement, and each rectifier equipment is designed so that full load may be carried for long periods on three units. This enables one unit to be withdrawn from service for inspection, cleaning or maintenance, without reducing the total cell line current.

Since the transformers are situated out-of-doors, the secondary connections to the rectifiers are brought through the substation walls and carried above the d.c. breakers before dropping down to the rectifier terminals. The three-phase connections to each rectifier cubicle are kept separate, so there are altogether nine low-voltage terminals on the transformer and nine separate leads to the eighteen rectifier terminals. Each lead is made up of three 4in by ¼in copper bars. The layout of these bars was designed to minimise the resistance and reactance voltage drops, and to ensure that the secondary reactance of the leads to each cubicle were the same. This precaution has resulted in excellent current sharing between the three cubicles on every unit.

Each cubicle contains six trays holding 432 germanium cells, together with their associated fuses and alarm indication circuits. The cell and fin assemblies are secured to a panel of bonded paper insulation held in a metal frame. Six of these trays are mounted vertically side by side in steel tubular frames, and connections to the cubicle busbars are made by captive bolts with pressure-line contacts ; one a.c. connection is at the top of the tray and two d.c. connections at the bottom. The cells are connected three-phase bridge with three cells in series, and there are twenty-four strings in parallel in each arm of the bridge, as shown in Fig. 7. At maximum load each string of three cells carries a peak current of 140A. Every two parallel strings of series cells on both sides of the bridge is protected by an h.r.c. fuse, and a small current transformer is connected in the lead to each pair of fuses. The six current transformers on each tray operate separate flagged indicator relays with auxiliary contacts. Should any cell fuses blow in service, an audible alarm is sounded and the flag indicators in the rectifier cubicles, together with those on the control cubicles, give immediate indication of the unit, cubicle and tray in which the open circuited fuse is situated. No fuse has blown since the equipment was commissioned.

The cells are protected against overvoltage surges by two separate surge-absorbing circuits. One of these circuits consists solely of capacitors which are connected across the rectifier a.c. terminals and mounted inside each rectifier cubicle. These capacitors are designed to prevent voltage surges occurring at the end of every commutation. If they were not fitted, the sudden interruption of reverse current after every conduction period would produce high-frequency voltage oscillations in the inductive rectifier circuits. The magnitude of such oscillations can be several times the normal peak inverse voltage.

The second circuit, which consists of resistors and capacitors, is also connected across the rectifier a.c. terminals, but is separately mounted in a small cubicle, and serves the complete rectifier unit. The function of this circuit is to reduce the amplitude of occasional line surges which occur principally as the result of switching.

The rectifier cubicle fans draw air in at the bottom rear of the cubicle past the rectifier cooling fins, and exhaust it through the cubicle top. Alarm indication is provided to give warning if the temperature of the exhaust air from the cubicle becomes excessive, and should the air flow completely fail the unit a.c. breaker is automatically tripped.

A single-pole 3500A circuit breaker fitted with a reverse current trip is connected to the positive terminal of each rectifier cubicle, and the three circuit breakers are connected together on the output side. From the breakers, 10,000A, d.c. bars run in floor trenches to the unit isolators mounted on the wall adjoining the cell hall. Here all four units are paralleled and the supply is fed into the cell hall.

All auxiliary low-tension a.c. supplies are taken from a switchboard installed in the rectifier room, which is energised from two 500kVA stepdown transformers.

Control and Metering Equipment

The rectifier equipment for each cell line is operated from a master control desk which, together with its associated indicating, metering and unit control panels, is situated in the central control room.

The controls on each desk are kept to a minimum to simplify the operator's work. Only the master switches normally used by the operator to control or adjust the total cell line current are mounted there, all others being mounted on the general control panels, which are positioned in front of the desks. The desk controls comprise a large-scale d.c. ammeter and voltmeter, a tap-change switch

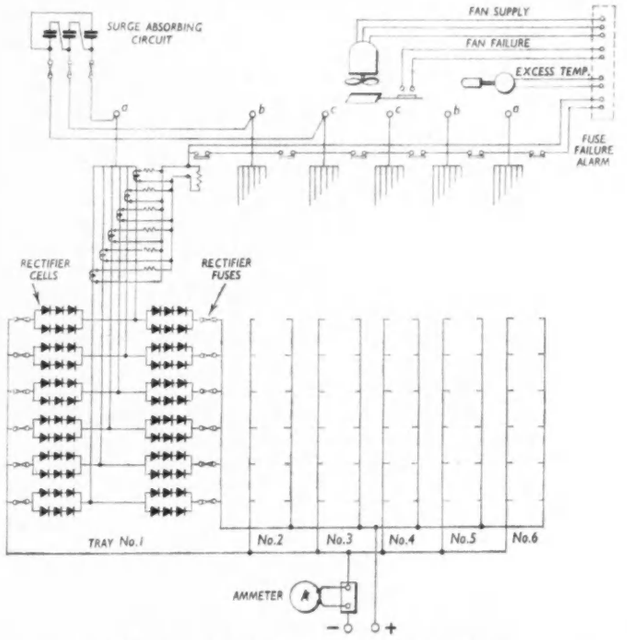


Fig. 7—Connection diagram of each rectifier cubicle

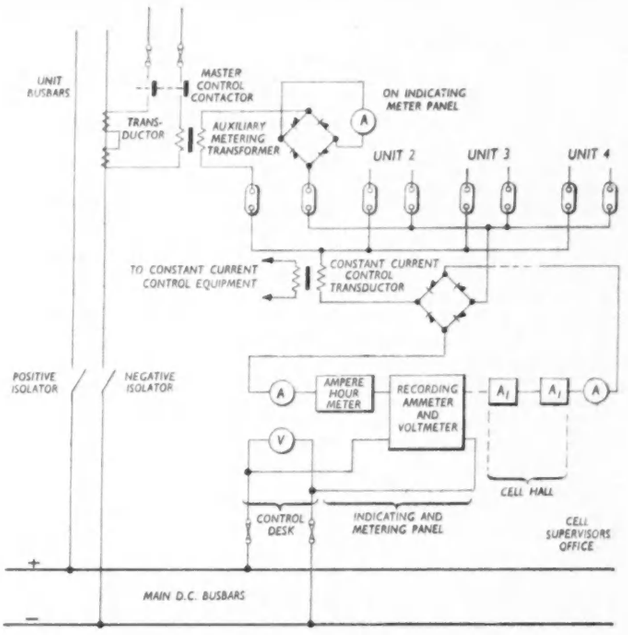


Fig. 8—D.C. metering circuit

for parallel control of the unit regulating transformers, a control switch for parallel control of the induction regulator driving motors, a changeover switch for either manual or automatic control of current and a rheostat for setting the value of current to be automatically controlled.

Facilities on the control board enable the voltage of the rectifier units to be controlled individually, both by transformer tap changes and by altering the position of the induction regulator rotor. Control switches also permit the units to be switched in and out independently. Each set of rectifier unit controls is provided with a changeover switch which enables any three or all four of the units to be transferred to the master control switches on the desk.

Each section of the rectifier unit control panel is also equipped with a d.c. ammeter for each unit and switches controlling the sub-station ventilating fans. The centre of each equipment control panel is provided with control switches for the main and stand-by motor-amplidyne sets which are used for controlling the induction regulators either under parallel hand control or parallel automatic constant-current control. A cell line d.c. ampere-hour meter and a duplex cell line current and voltage recorder are also mounted on this section of the control panel. Between the two equipment control panels there is a common centre section, on which are mounted the control switches for the tap-change gear on the 33/11kV incoming transformers, together with a tap-position indicator and 11kV busbar voltmeter. These controls enable the rectifier sub-station operators to monitor and control the 11kV busbar voltage.

When the rectifier units are operated in parallel from the master control desk it is essential to ensure that the induction regulators remain in step even though they may carry out a large number of small movements in either direction when minor adjustments are made to maintain the constant current conditions. To avoid out-of-step operation under these conditions, a master selsyn transmitter is used to control the movement of the individual selsyn motors driving the trimming regulators. As a further precaution to ensure correct alignment of the induction regulators and therefore equal sharing of the total load, the units under parallel control only make a tap change together when all induction regulators have reached the end of their travel.

The d.c. metering scheme is similar to that employed on previous B.T.H. heavy current rectifier installations, and employs metering transductors mounted in the negative copper work of each unit between the paralleled rectifier terminals and the d.c. busbars isolators, as shown in Fig. 8. The output from each transductor is used to provide indication of unit current on the metering panel in the control room, whilst the summated output of the four transductors is used to give indication of the total cell line current. This summated signal serves the ammeter on the control desk, an instrument in the cell hall supervisor's office, two large-scale meters, A_1A_1, in the cell hall, and the recorder ammeter. A small current transformer in the ammeter circuit provides the signal required to operate the constant current control equipment.

Constant Current Control Equipment

The total cell line current supplied by each rectifier equipment is normally maintained constant to within ± 100A of any selected value within the working range, by automatic control applied to the induction regulators. Under this condition, the motors driving the induction regulators are operated in unison from a selsyn transmitter rotor which is driven by a reversible driving motor. The supply voltage to the selsyn unit driving motor is at all times proportional to the difference between the selected setting value of cell line current and the actual cell line current which is flowing.

A schematic diagram of the constant current control scheme is shown in Fig. 9. A signal proportional to actual cell line current is obtained from the summated metering circuit by a current transformer. The signal from this current transformer is rectified and fed to a tapped load resistor to provide a voltage signal proportional to load current. The tapping on the load resistor provides a suitable voltage for comparison with the working voltage of a gas-filled valve V_6, which operates in cascade with a second valve V_5 to give a reference voltage across potentiometer P_6. Due to the characteristics of these valves, variations in the supply voltage change the valve currents without appreciably altering their operating voltage. Only a small fraction of the supply voltage variation appears across V_5, a much smaller fraction appears across V_6, and the reference voltage at P_6 is thus constant and virtually independent of the supply variations.

The output from the potentiometer is proportional to the required current and can be adjusted to the particular load current required, while the signal voltage obtained from the metering circuit is injected across resistance R_6. The difference between the two voltages is applied to the control grid of valve V_1, while the control grid of a second valve V_2 is connected to the mid-point of the amplifier d.c. supply. The outputs from valves V_1 and V_2 are connected through potential dividers to valves V_3 and

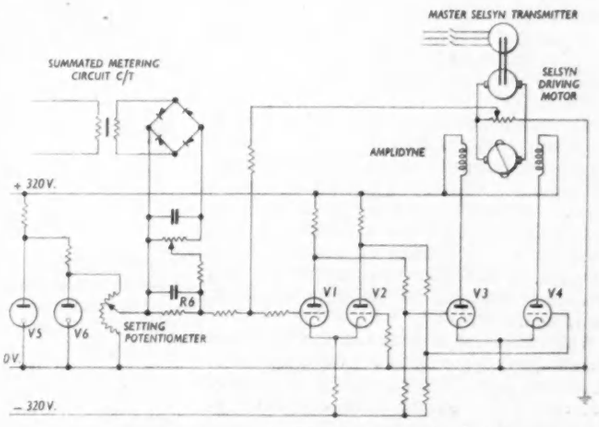


Fig. 9—Simplified diagram of the constant current control scheme

V_4 which control the current flowing in the fields of an amplidyne. The output from this rotating amplifier controls the master selsyn driving motor, and hence, through the unit induction regulator, also controls the cell line current.

If the automatic constant-current control equipment is operating at a set value of current and the setting is then raised, or if the actual current in the cell line decreases due to a fall in the supply voltage or a rise in the back electromotive force of the chlorine cells, then a positive signal representing the error in current appears at the grid of valve V_1. This increases the current through V_1 and momentarily raises the potential of the coupled cathodes. Hence the grid-to-cathode voltage of V_2 is reduced and the current through it also reduced. This results in the anode voltage of V_1 decreasing and that of V_2 increasing, and because these anode voltages are applied to the grids of V_3 and V_4, valve V_3 current decreases and valve V_4 current increases, resulting in out-of-balance between the amplidyne field current and an output voltage from the amplidyne set to the master selsyn driving motor. A proportion of this output voltage is fed back to the grid of valve V_1 through a potentiometer and resistance (as negative feedback) for stabilising purposes. The selsyn driving motor then operates to increase or correct the total current. If the signal applied to the grid of valve V_1 is negative the selsyn is driven in a direction to decrease the total output current. A current limiting circuit which is not shown on the diagram is incorporated to prevent excessive accelerating and decelerating current flowing in the amplidyne set.

Layout of Substation and Electrical Equipment

The dimensions of the rectifier substation were fixed by two considerations : (1) that the length of the substation should be no greater than the width of the cell hall, and (2) that the substation width should be kept to a minimum, to reduce the length of low voltage interconnections. All the rectifier equipment is housed in a single-storey building, with the four rectifier units arranged symmetrically on either side of the central area, where are situated the common controls, motor amplidyne and selsyn sets for each cell line, and the auxiliary switchgear.

Each unit comprises three rectifier cubicles, a unit control cubicle, a surge suppression cubicle and three d.c. circuit breakers. All this equipment is grouped together within a separate screened area with the rectifier and unit control cubicles arranged at the front as illustrated on page 408. This effectively screens line conductors and conveniently segregates units for isolation so that routine cleaning and maintenance can be carried out in safety without reducing power fed to the cell lines.

The rectifier substation has a closed circuit ventilating scheme with the air recirculated through air-to-water heat exchangers mounted on the roof. There are eight such coolers, one for each rectifier unit. Air is extracted from the building near ceiling level at a point above each group of cubicles, drawn through the cooler and returned to the floor level of the building by a fan mounted in the downcoming ducting.

The ventilating scheme has the important advantage that the air in the building can be kept cool, free of atmospheric pollution and non-corrosive. The resulting cleanliness of the substation reduces the amount of maintenance required on the control and relay equipment and on the rectifier cubicles. A quantity of make-up air is introduced into the closed system through air filters, situated on the roof. Should the cooling water pump fail or a major water leak occur, it is possible to open panels in the cooler ducting so that air can be drawn directly into the downgoing ducts and exhausted to the atmosphere without entering the heat exchangers.

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Fully Transistorised Frequency Modulated Indicator for Field Tests

By R. C. ROBSON, B.Sc. (Hons.),* A. GOODIER,* AND R. G. PENN†

No. II—(*Concluded from page 377, March 6*)

An electronic indicator for translating mechanical parameters into electrical ones has been developed for field use by the Thornton Research Centre, Chester. In it thermionic valves have been replaced by transistors and crystal diodes. It has proved so reliable in service that it is expected to make obsolete most of the indicators at present used by Shell Research, Ltd.

The Link Between Transducer and Oscillator

THE variable capacitance transducers used with a frequency modulated indicator are connected in parallel with the tuned circuit of its oscillator. There is a limit to the total capacitance which may be placed across this circuit because the oscillator and demodulator must be tuned to a common frequency. So, in order to provide the maximum flexibility possible in the design of transducers (i.e. to provide a system in which transducers with a large standing capacity may be used if required), the length of the transducer/oscillator lead has been fixed at 4ft. For work in which the transducer is at ambient temperature, polythene cables are used. Where the transducer necessarily runs hot, as when delineating cylinder pressures,

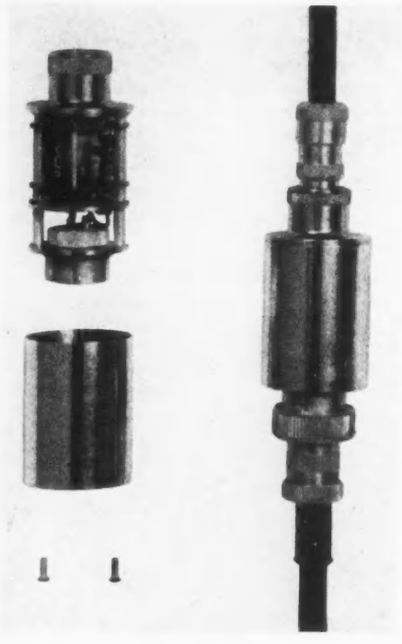

Fig. 9—The oscillator

a special cable is used. It is insulated with polytetrafluoroethylene and has the inserts of its terminations made from the same material. This may be seen in Fig. 4(*ante*).

Additional flexibility in the design of variable inductance transducers has been provided by the use of alternative series coupling condensers (100pF and 220pF) which are potted in "Epikote" resin and housed in the line adaptors which may be seen in Figs. 7(*ante*) and 8(*ante*).

The Oscillator

The use of short standard transducer/oscillator leads means that the oscillator must be located close to its transducer. Fig. 9 shows the mechanical construction of the oscillator. It is made to hang suspended on its transducer and demodulator cables. (Its weight is only 110 g.). In order to keep down the overall bulk of the indicator, we have made the demodulator a fixed frequency device[11] and provided means whereby the oscillator may be tuned to suit it. The circuit of the oscillator employs a single transistor, as shown in Fig. 10. At the time the oscillator was designed, the upper frequency limit of available junction transistors[12] was 500 kc/s. It was therefore necessary to fix the frequency of the oscillator somewhat below this figure. It so happens that the frequency at which the most efficient R.F. coils may be made, using available pressings of manganese zinc ferrite, lies around 200 kc/s. Accordingly, the nominal oscillator frequency was made 180 kc/s.

The power required to drive the oscillator is fed in by the cable joining it to the demodulator (which houses two 4·5V dry batteries). A second conductor in this cable enables the oscillator to be tuned from the demodulator in the following way. The tank circuit inductance of the oscillator, SEC.2 (see Fig. 10) is housed within a ferrite pot secured to the shank of a mumetal core *A*. This

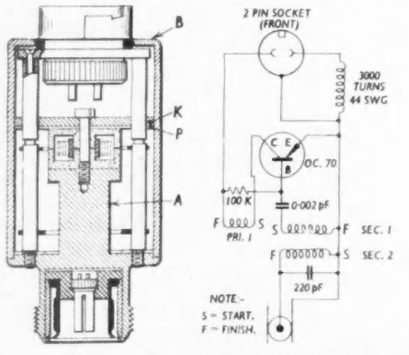

Fig. 10—The oscillator (less components and windings) and circuit diagram

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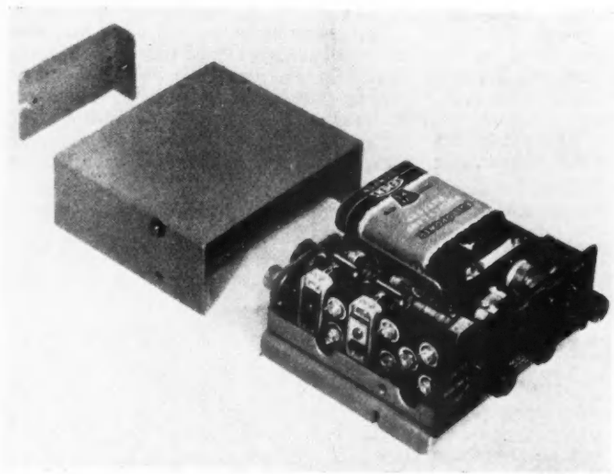
† Now with Shell-Mex and B.P., Ltd.

[11] The demodulator incorporates stagger tuned resonant circuits whose frequency difference is carefully adjusted during manufacture. A tunable demodulator would require a pair of accurately aligned ganged capacitances. These are large components.

[12] Experience with early point contact types showed they were very easily damaged by accidental electrical overloads.



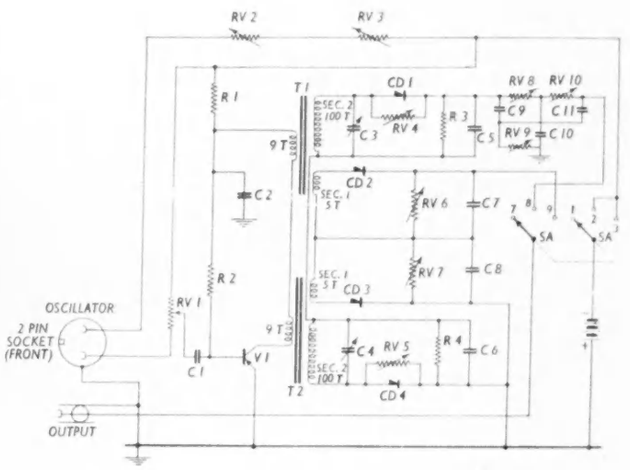


Fig. 11—Demodulator and circuit diagram

core, the ferrite, a 0·0085in/0·0090in mica disc *P*, a mumetal plate *K* and mumetal case *B*, form an auxiliary magnetic circuit. If the ferrite is polarised by passing a few milliamperes direct current through the 3000-turn coil wound on the shank of *A*, its effective permeability is reduced and the frequency of the oscillator rises. Coarse and fine resistors built into the demodulator control the d.c. polarising current. It should be noted that the mumetal case also provides a magnetic screen, without which the oscillator is extremely sensitive to stray fields.

The Link Between Oscillator and Demodulator

Standard two-core cables 10ft long are used to connect the oscillator to the demodulator. Extension leads of the same length are also available. The oscillator is not very sensitive to the capacitance of this cable and will work satisfactorily provided it does not exceed about 5000pF.[13] This corresponds to 100ft of lead.

The Demodulator

The demodulator is shown in Fig. 11. Its function is to convert the information contained in the fluctuating frequency from the oscillator into a form which may be applied to appropriate display units. It produces a voltage output strictly proportional to the difference between the instantaneous frequency of the oscillator and its frequency when the mechanical parameter is in some reference state (e.g. zero pressure, closed position of fuel injector needle, T.D.C., &c.).

Consider a single resonant circuit such as the 100-turn R.F. coil SEC.2 (see transformer *T*1 in the circuit diagram) and its associated capacitor, *C*3. This coil is designed to have low electrical losses[14] and during manufacture the value of *C*3 is nicely adjusted so that it resonates at 177 kc/s. If the nine-turn primary coil of the R.F. transformer *T*1 is excited by a constant amplitude current, the frequency of which is slowly swept through 177 kc/s, the oscillating voltage appearing across *C*3 will vary in the manner shown in Fig. 12 (*i*). Unless the frequency of the exciting current is at or near 177 kc/s, the tuned circuit shows a very small response. When the voltage across *C*3 is rectified, the d.c. component of the output voltage will vary with the frequency at which *T*1 is excited in just the same way.

[13] At this value of capacitance the output voltage of the oscillator is half that with no added capacitance.

[14] $Q = 190$ approximately.

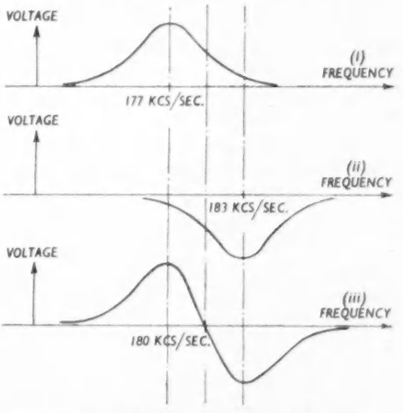
Now consider the second identical R.F. transformer *T*2, whose 100-turn secondary winding has been tuned by *C*4 to resonate at the slightly different frequency of 183 kc/s. If it is excited by the same variable frequency primary current as *T*1, the d.c. component of its rectified output voltage will change with frequency, as shown in Fig. 12 (*ii*). Note that in this case the rectifier has been connected so that the output voltage is of opposite polarity to that of *T*1. Again, there is negligible output except at and near the resonant frequency.

If now, the outputs of the two tuned circuits are connected so that they add algebraically, the resultant d.c. component of the rectified voltage output varies with excitation frequency in the manner shown in Fig. 12 (*iii*). This is the so-called "S-curve." It is possible to control the shape of this curve by appropriate adjustment of the electrical losses of the two tuned circuits[15] and of the stagger frequency (6 kc/s) during manufacture. The d.c. output of the demodulator may be made strictly proportional to deviations of the input frequency from 180 kc/s over the range 178·5 kc/s to 181·5 kc/s.

The fact that the demodulator will not respond when excited by frequencies more than a few kilocycles per second different from 180 kc/s is of great importance. It renders the F.M. system of indication exceptionally immune to electrical interference.[16] The amplitudes of the voltages developed by *T*1 and *T*2 are proportional to the magnitude of the identical currents flowing in their primary coils (which are connected in series), as well as being frequency dependent in the manner discussed above. The signal from the oscillator has therefore been fed to the two transformers via transistor *V*1 which acts as a limiting stage and renders the excitation of the stagger-tuned resonant circuits independent of the amplitude of the oscillator.[17] The calibrated gain control *RV*1, mounted on the front panel of the demodulator, is interposed between the oscillator and transistor *V*1. It forms the sensitivity control of the indicator.

The output derived from the 100-turn coils of the two R.F. transformers is suitable for feeding display units having high impedance input circuits (pre-amplifiers of pen recorders or cathode-ray oscilloscopes). In order to make it possible to display less rapidly changing mechanical quantities on a moving coil meter or pen recorder, an alternative output at low impedance has been provided. This takes the form of two five-turn secondary windings (SEC. 1) with their associated rectifiers. Selection of the appropriate output is made by means of a three-position switch (Low Imp., High Imp., and Off) mounted on the front panel of the demodulator.

In addition to the d.c. component of the output from the rectifiers there is also a component at oscillator frequency. This is ignored completely by moving coil instruments but is an embarrassment when the display unit is a cathode-ray oscilloscope.[18] It is therefore necessary to filter out the carrier frequency in the case of the high impedance output. This must, of course, be done in such a way as to leave the indicator with an acceptable frequency response. It will be recalled that the present indicator has the low carrier frequency of 180 kc/s[19] imposed by the limitations of the transistors available at the time it was designed. It is therefore necessary to use a very selective filter of twin-tee configuration, comprising capacitors *C*9, *C*10, *C*11 and the preset resistors *RV*8, *RV*9 and *RV*10. The latter



(i) Tuning curve for circuit resonant at 177 kc/s.
(ii) Tuning curve for circuit resonant at 183 kc/s having rectified output reversed in polarity with respect to (i).
(iii) Algebraic sum of rectified output voltages of the above.

Fig. 12—How the demodulator works

[15] By means of the resistors *RV*4 and *RV*5.

[16] The energy content of most forms of interference is spread out over a very wide range of frequencies. The demodulator can only respond to the minute amount of energy contained in a frequency band a few kilocycles per second wide.

[17] This at least was the intention. The limiting action is in fact not very effective. On the other hand, the amplitude of the signals from the oscillators has been found to be unexpectedly stable.

[18] It elongates the spot on the tube face.

[19] The commercially available F.M. indicator previously referred to uses a 2 Mc/s carrier.

are accurately adjusted during manufacture of the demodulator.

Oscillator and demodulator both draw their power from two 4·5V dry batteries in parallel, which will run the indicator for several weeks. The d.c. polarising current by means of which the oscillator is tuned is also drawn from these batteries. Its value is controlled by two variable resistors in series, *RV*2 and *RV*3. Both are located on the front panel of the demodulator. *RV*3 (1000 ohms) forms the coarse tune adjustment and *RV*2 (100 ohms) is the fine tune adjustment.

The Link Between the Demodulator and the Display Unit

Whenever frequency response is important, it is undesirable to shunt the output of the demodulator with more capacitance than necessary. Standard cables 2ft long have therefore been provided for coupling it to a cathode-ray oscilloscope.

The Performance of the Indicator

Fig. 13 shows a transfer characteristic of the indicator, using its high impedance output. The voltage from the demodulator (when working into a load of 1 megohm) was plotted as the recorder's pen deflection and the chart movement was made proportional to the instantaneous value of a variable air capacitor which simulated the transducer. It is evident that in this way the recorder may be made to portray the " S-curve " the central portion of which is shown. The time taken to record the curve was about one minute. It therefore represents the transfer characteristic for slowly varying quantities. The components used in the oscillators and demodulators are not specially selected and therefore the sensitivity and linear range of the individual indicators vary somewhat. The average range over which the output voltage is strictly proportional to the incremental capacitance of the transducer is 14 pF.[20] The average sensitivity is 750 millivolts per micro-microfarad at full gain.

A similar characteristic taken from the low impedance output of the demodulator (when working into a load of 1600 ohms) is shown in Fig. 14. It will be observed that this characteristic is not quite so linear as the previous one.[21] The average voltage sensitivity using the low impedance output is 10 millivolts per micro-microfarad at full gain.

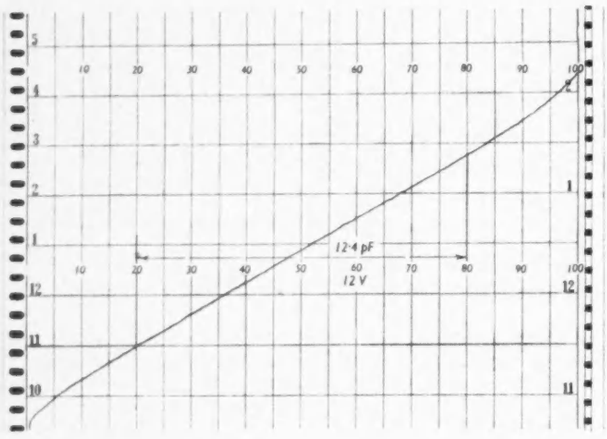


Fig. 13—Transfer characteristic of F.M. indicator. High impedance output

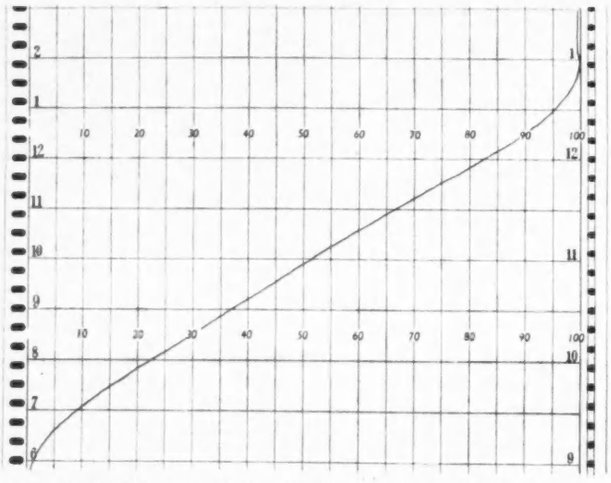


Fig. 14—Transfer characteristic of F.M. indicator. Low impedance output

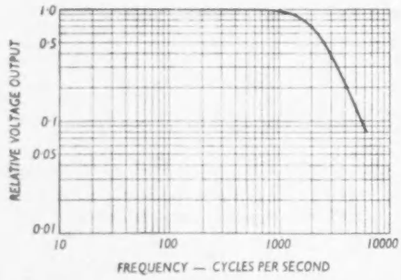


Fig. 15—Frequency response of F.M. indicator

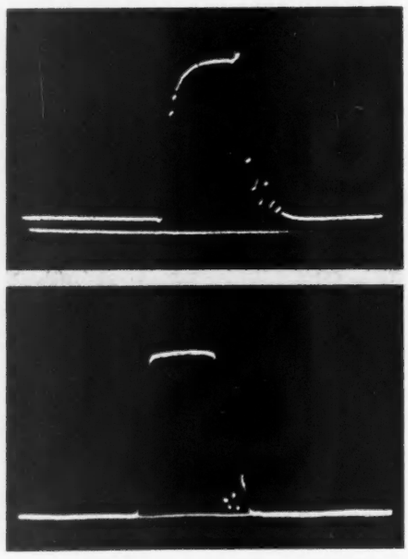
The response of the indicator is a maximum for slowly varying quantities and changes with frequency in the manner shown in Fig. 15. The d.c. response is halved for a mechanical quantity varying sinusoidally at 2500 c/s. In order to appreciate what this means in terms of the fidelity of the response of the indicator to a step-function, consider Fig. 16. This shows two oscillograms taken under identical conditions, in which the needle of a fuel injector was open for 5 milliseconds in both cases. The upper diagram was taken using a voltage-generating magnetic transducer followed by an electronic integrator (the arrangement used in a portable engine indicator previously developed at Thornton Research Centre). The lower one was taken using the F.M. indicator and the variable inductance needle-lift transducer shown in Fig. 7. The best criterion of the frequency response is probably the sharpness of those corners of the diagrams which correspond to the initial rise of the needle. It is evident that the fidelity of the F.M. system is considerably better than that of the portable indicators.[22]

The stability of the indicator depends almost entirely on the constancy or otherwise of the d.c. magnetisation which controls the frequency of the oscillator.[23] As the batteries run down the frequency generated by the oscillator gradually falls. The magnitude of this drift is about 4pF per hour one hour after switching on, falling steadily to about 1pF per hour after ten hours.

The power consumption of the indicator is 50 milliwatts (maximum), depending on the value of the polarising current to the oscillator.

Conclusion

The indicating system which has been described is based on limited experience of semiconductor electronics. It will undoubtedly become possible to design better equipment in future. For example, transistors with better high-frequency characteristics will make possible the extension of the frequency response of the apparatus and the proper application of Zener diodes will materially improve its stability. Nevertheless, the indicator in its present form has proved extremely useful. The range of transducers that have been described makes it clear that it has enabled measurements in the field to be made with a facility which was previously impossible.



Above : Portable engine indicator using variable reluctance transducer.

Below : F.M. indicator using variable inductance transducer.

Fig. 16—Comparative needle lift diagrams at 600 r.p.m. Needle opens at 332 deg. ; needle closes at 350 deg.

Acknowledgment

The authors wish to express their thanks to the directors of " Shell " Research, Ltd., for permission to publish this article.

[20] This very comfortably exceeds the 5 pF change for which the variable capacitance transducers are designed.

[21] Because of the curvature of the characteristics of the crystal diodes *CD*2 and *CD*3. (See Fig. 11.)

[22] These were originally designed for field work and the deficiencies of the variable reluctance transducers were tolerated because the associated electronics were much simpler than with a thermionic valve version of an F.M. system.

[23] That this is so is evident from the performance of oscillators we have built incorporating a tunable capacitor. This type, however, is not suitable for field use because it cannot be tuned from a distance.

High-Temperature Gas-Cooled Reactor Project

Twelve European countries, including Great Britain and the Euratom group, are proposing to collaborate in a study of the use of high-temperature gas-cooled reactors for nuclear power stations. An agreement to this effect is expected to be signed by the participants later this month. The project will hinge upon the building and operation of an experimental reactor (generating 10MW thermal) at the Winfrith Heath establishment of the United Kingdom Atomic Energy Authority. An outline of the project is given here.

A JOINTLY run European project based on an experimental high-temperature gas-cooled reactor has been approved by the steering committee of O.E.E.C.'s European Nuclear Energy Agency. Twelve European countries, including Great Britain and members of Euratom, propose to combine in a five-year programme for joint investigation of the use of high-temperature gas-cooled reactors for nuclear power stations and other applications. Reactors of this kind, a further development of the present Calder Hall design and the higher-temperature advanced gas-cooled reactor already being developed in Great Britain, should enable greater efficiency to be obtained in a plant of more compact size.

The new project, known as "Dragon," was originally suggested by the British in March, 1958. It will involve the construction and operation of an experimental power-producing reactor (10MW thermal) at the Winfrith Heath, Dorset, establishment of the United Kingdom Atomic Energy Authority, where a zero energy high-temperature gas-cooled reactor is already being constructed by the Authority. This reactor is expected to become critical in June and will provide valuable information for the higher-power experiment.

In addition to the work at Winfrith Heath the new agreement covers a programme of research and development, with the participation of all the countries, leading to a wider knowledge of high-temperature gas-cooled reactors. The total estimated cost of this programme, including the construction of the experimental reactor, is estimated at £13,600,000, £10,000,000 of which will be shared among the participating countries and organisations, while the excess £3,600,000 will be borne by the United Kingdom, which will retain ownership of the reactor and other installations in England at the conclusion of the project. It has been estimated that the "Dragon" project will initially require some seventy designers, including thirty professional engineers, plus the supporting services of up to 100 professional research and development scientists and engineers. The new reactor is expected to be completed in 1962.

The countries participating in the project are: Austria, Belgium, Denmark, France, the German Federal Republic, Italy, Luxembourg, the Netherlands, Norway, Sweden, Switzerland and the United Kingdom. The formal Agreement is expected to be signed at O.E.E.C. Headquarters in Paris in March.

It may be recalled that previous joint nuclear energy undertakings initiated by the European Nuclear Energy Agency include the twelve-country Convention setting up the European Company for the Chemical Processing of Irradiated Fuels (Eurochemic), with plant and laboratories at Mol in Belgium; and a Boiling Heavy Water Reactor at Halden in Norway, in the operation of which five O.E.E.C. member countries and the Euratom Community are participating.

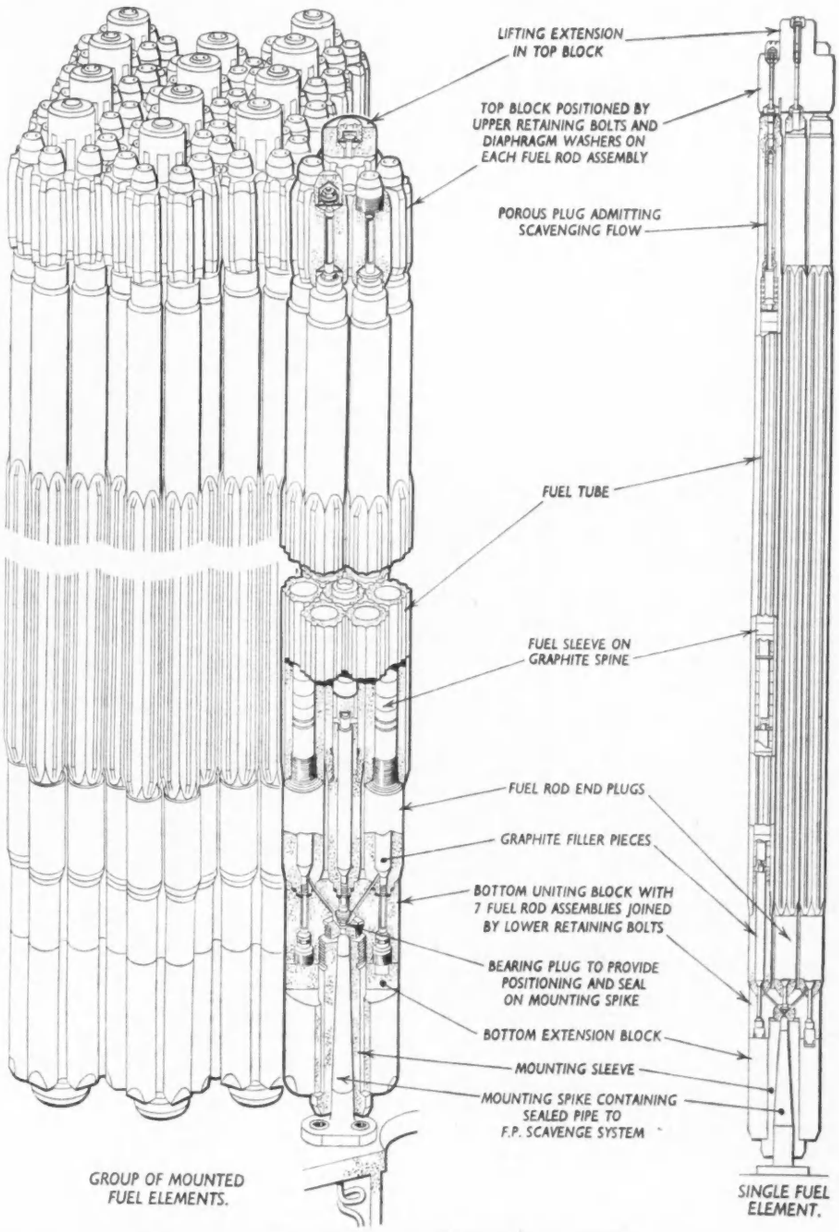

LIFTING EXTENSION IN TOP BLOCK
TOP BLOCK POSITIONED BY UPPER RETAINING BOLTS AND DIAPHRAGM WASHERS ON EACH FUEL ROD ASSEMBLY
POROUS PLUG ADMITTING SCAVENGING FLOW
FUEL TUBE
FUEL SLEEVE ON GRAPHITE SPINE
FUEL ROD END PLUGS
GRAPHITE FILLER PIECES
BOTTOM UNITING BLOCK WITH 7 FUEL ROD ASSEMBLIES JOINED BY LOWER RETAINING BOLTS
BEARING PLUG TO PROVIDE POSITIONING AND SEAL ON MOUNTING SPIKE
BOTTOM EXTENSION BLOCK
MOUNTING SLEEVE
MOUNTING SPIKE CONTAINING SEALED PIPE TO F.P. SCAVENGE SYSTEM
GROUP OF MOUNTED FUEL ELEMENTS.
SINGLE FUEL ELEMENT.

Fig. 1—Fuel element for high-temperature gas-cooled experimental reactor

Proposed 10MW Reactor Experiment*

A general arrangement of the reactor, as envisaged during the preliminary design study, is shown in Fig. 2 and, although further work on design detail will certainly involve many modifications, the drawing serves to illustrate the basic principles which would underlie the final design.

The fuel elements in this system are constructed from graphite, U235, and thorium. Each fuel element consists of seven closely packed rods, united to form a hexagonal array, as illustrated in Fig. 1. Each fuel rod has a sheath of graphite on the outside and a mixture of moderator, fissile and fertile materials inside the sheath. In the particular design illustrated in the figure, the mixture forms an annular fuel insert around a central graphite spine, but alternatively it could be in the form of a solid rod within the sheath. Each fuel rod contains at its upper end an inlet vent containing a porous plug through which a bleed flow of coolant gas passes, while at the bottom each of the seven rods is vented into a common duct in the block which holds them together and which seats on to a hollow mounting spike through which fission products are extracted.

* Extract from a paper presented by L. R. Shepherd, R. A. U. Huddle, L. A. Husain, G. E. Lockett, F. Sterry and D. U. Wordsworth at the Second Conference on the Peaceful Uses of Atomic Energy, Geneva, September, 1958.

Each fuel element is 8ft (approximately 2·4m) long and the individual rods, each a little over 6ft long, are sealed to the bottom block and retained with metal bolts. At the upper end, the rods are joined to a spider-shaped block by metal cap-bolts and diaphragm washers to accommodate any unequal growth or expansion. An appreciable length change in an individual rod will not induce serious resisting forces since the diaphragm mounting washers will readily yield at the working temperature. The top block is shaped to position neighbouring elements and a lifting extension is provided for handling.

Sixty-one of the seven-rod fuel elements make up the core of the reactor, the actual core geometry being roughly a cylinder of 4ft length and diameter (Fig. 3). The closely packed rods have surfaces shaped to define a number of passages through which the coolant passes, the total voidage in the core due to these passages being approximately 13 per cent of the total core volume. The fuel elements, of course, make up not only the 4ft length of core, but also the end reflectors, roughly 2ft thick at each end. Around the assembled fuel elements is a side reflector made up of graphite columns 8ft in height with an overall diameter of 10½ft. About 5 per cent coolant voidage is provided in this side graphite.

Both the reflector columns and core elements stand vertically and are pivotally mounted on steel structural members inside a steel pressure vessel, the reflector being arranged to close on to the core to provide an expandable restraint at the top of the fuel elements. For a 10MW output the coolant is helium, at 10 atmospheres pressure, which enters and leaves by ducts near the top of the pressure vessel. The incoming coolant flows downward and maintains the inside of the pressure vessel and the bulk of the side reflector at a temperature not greatly different from the gas at 350 deg. Cent. It subsequently flows upward through the core from which it emerges into a Nimonic chamber at a mixed mean temperature of 750 deg. Cent. The outflowing gas is transferred through a Nimonic-lined duct to the primary heat exchanger which is water cooled in the arrangement illustrated. It should be noted that the Nimonic chambers and ducts are externally cooled by the incoming coolant and they have no structural function. No part of the primary circuit, which has to withstand the full coolant working pressure, is normally exposed to gas at more than 350 deg. Cent.

Secondary cooling water emerges from the primary heat exchanger at a relatively low temperature, i.e. about 75 deg. Cent., so that no excessive pressurisation is required and a heat exchanger of small dimensions results from the large temperature difference between the hot gas and the cooling water. Other possible alternative arrangements using an intermediate heat transfer fluid to avoid any possibility of water leakage into the main circuit might be considered. No attempt to generate steam and power is contemplated in this study.

A feature in the primary cooling circuit is the proposal to avoid shaft seals and to use instead completely enclosed motors and compressors with gas bearings. It was not anticipated that a free running gas turbine circulator would be developed in time to be used in this reactor experiment and the required pumping power, of the order of 100kW, is so low that it would not provide a particularly useful exercise for the principle.

The inset view in Fig. 2 shows a single circuit with two circulators in series, an arrangement which avoids control valves. However, alternative systems using parallel circuits are worth further consideration and a number of possible circulator and heat exchanger layouts should be examined, before a final choice is made.

Control of the reactor is exercised by means of a curtain of absorbing rods, thirty in number, moving in vertical channels near to the inside boundary of the reflector. These rods provide a small negative reactivity for shut-down and their removal compensates for temperature coefficient, poison and depletion, a total range of reactivity between 14 per cent and 15 per cent being controlled. The possibility of using boron as a burnable poison in the fuel inserts as a means of reducing the depletion compensation required from the control rods is also considered. It is proposed that the control rods would be actuated by cable drives with the provision of magnetic clutches in the winding mech-

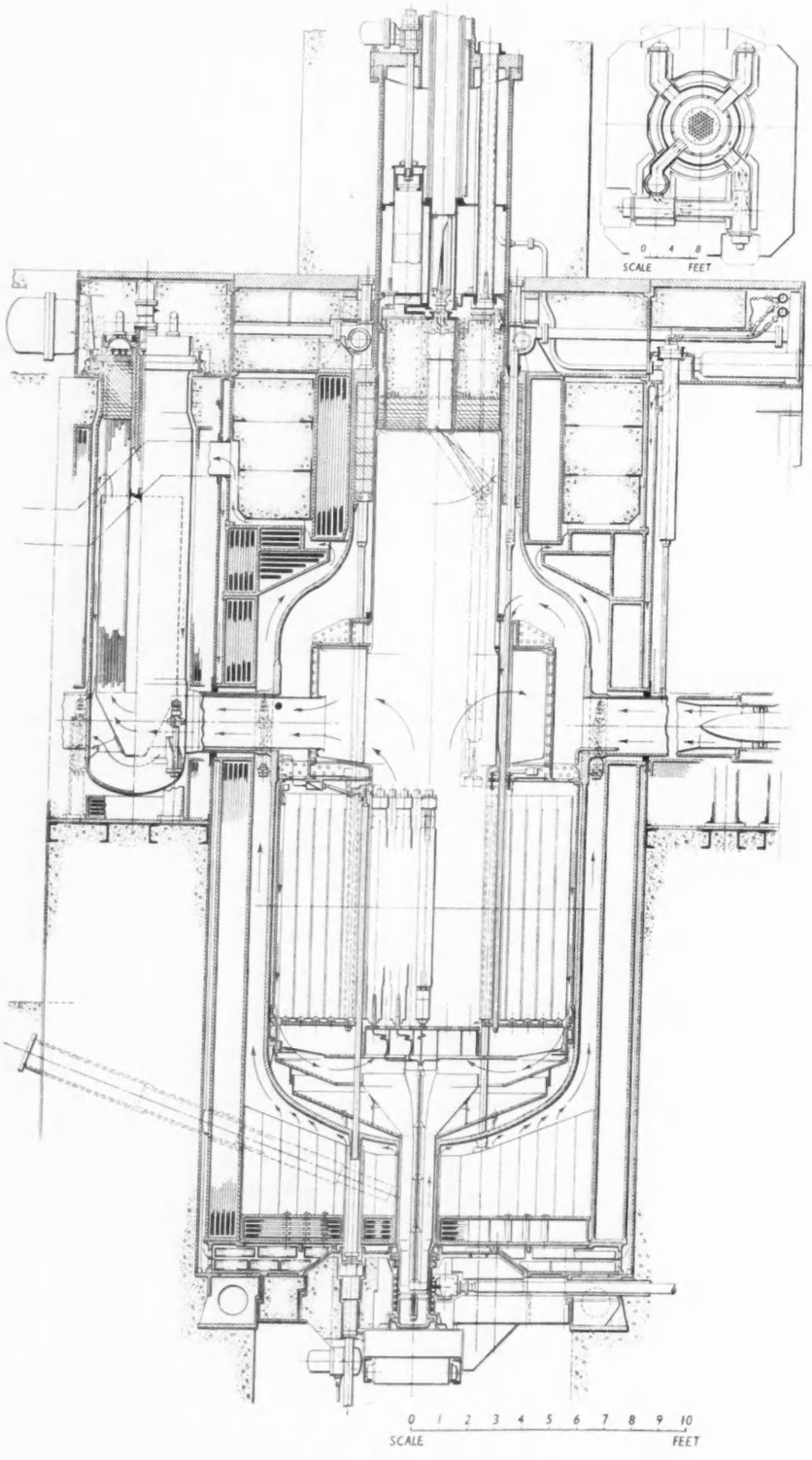


Fig. 2—High-temperature gas-cooled experimental reactor

anisms to release the cables in the event of an emergency shut-down requirement. In order to protect the actuators from any primary circuit activity, zirconium sleeves are provided which isolate these control mechanisms from the circuit gas and thereby simplify maintenance.

In a reactor of this kind it is important that one should be able to load and unload fuel elements without disturbing the helium coolant in the primary circuit. Accordingly, a charge/discharge machine capable of transferring elements through a gas lock is required, and the lower end of such a machine is shown in Fig. 2. The relative infrequency of fuel charging would enable the work to be carried out at a convenient shut-down period when gas temperatures are low and pressure correspondingly reduced. During reactor operation the charge/discharge machine would be parked in a shielded position where the temperature is kept low by a cooled by-pass of gas which subsequently flows back into the reactor.

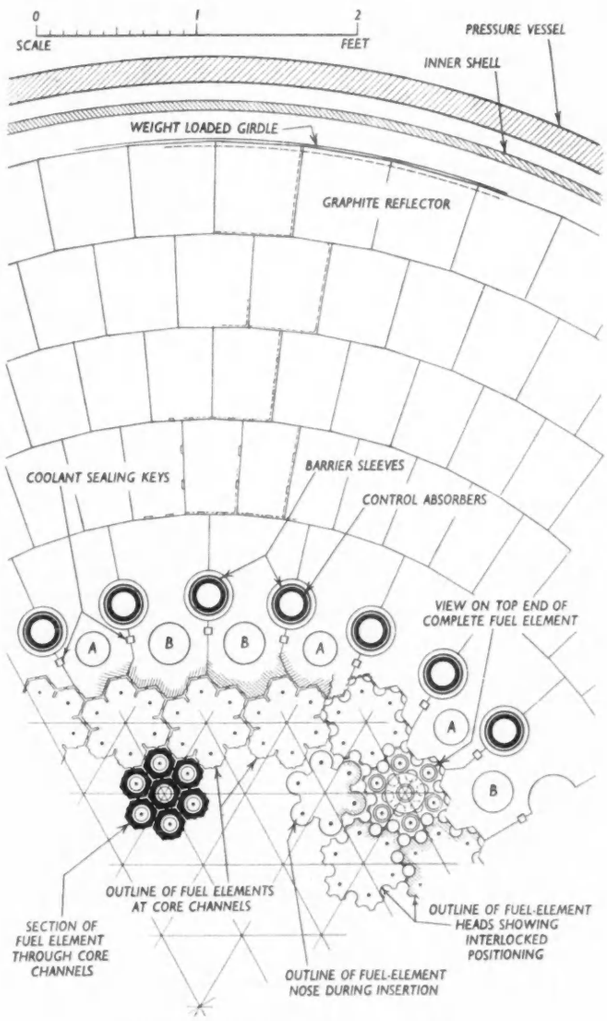


Fig. 3—Section of reactor core and reflectors

The fission products pumped from the bottom of the fuel elements are passed through a fission product trapping system based on the use of active charcoal absorption beds. The emergent helium will still contain the longest-period Krypton and Xenon activities since these are merely delayed. This gas will also go through a chemical purifier to remove O_2, CO_2, CO and H_2O before returning to the main cooling circuit. It is anticipated that the main problem which will be encountered in the reactor experiment will revolve around the effectiveness of the traps and chemical purifiers. If the oxidising impurities in the primary circuit cannot be maintained in the region of a few parts per million, then the amount of mass transfer of carbon with unprotected fuel elements may cause embarrassment. Again, excessive radioactivity would set very stringent requirements on the leak-tightness of the primary gas circuits which might be extremely difficult to meet. The engineering will in any case involve successive stages of enclosure with monitoring of interspaces and controlled handling of any leakage. All joints will be permanently welded or seal welded and any penetrations through the vessel, such as load machine drives, will require several stages of sealing, finally backed by sealed capping enclosures. These will, in all cases, be at cool and accessible parts of the system. The design must also cater for a carefully controlled removal procedure with adequate shielding and sealing for any active member which could require replacement.

It is not anticipated that the high outlet gas temperature will cause any major difficulties in the design of the pressure circuit, but the design solutions must satisfy, not only normal running conditions, but temperatures and pressures arising from certain postulated fault conditions. An appreciable but restricted flow of heat from the pressure vessel is desired to provide a cooling path in the event of primary circuit failure. Under such a fault condition excessive lagging could result in overheating of the pressure vessel, particularly if the reactor were not shut down; on the other hand an unrestricted heat flow would induce undesirable thermal stresses in the vessel. An adequate heat sink is available in the water cooled thermal shield which surrounds the vessel.

Outline of the Joint Programme of Research†

The scope of the research and development work needed for a high-temperature gas-cooled reactor is extensive and covers a wide range of subjects from neutron physics to specific engineering tests. Many of the more important studies demand the use of irradiation facilities in high flux research reactors, or of a zero energy reactor, but a large proportion of the work does not call for such special facilities and the location of this work is therefore not so restricted. The most important problems needing investigation are given in the following list :

1. The development of the fuel element graphite (or beryllia) sheaths in impermeable forms.
2. The fabrication of high-temperature gas-cooled reactor fuel elements from graphite and beryllia incorporating fissile and fertile materials.
3. The behaviour of the fuel elements and core materials under reactor conditions and changes in mechanical and thermal properties resulting from irradiation.
4. The mechanical properties of the large fuel element assemblies proposed for the reactor experiment.
5. Methods of processing the ceramic fuel inserts after their irradiation.
6. The compatibility of the coolant gas with the fuel elements, at high surface temperatures and resulting mass transfer problems. The influence of radiation in this connection.
7. The emission of fission products from the fuel inserts, at high temperatures, and their diffusion through the materials of the fuel elements.
8. The development of an efficient fission product trapping system to remove the volatile and particulate activities from the coolant and to delay active noble gases.
9. The chemical purification of the coolant gases to reduce to acceptable levels those impurities which might cause corrosion and mass transfer.
10. The selection of appropriate structural steels for the primary circuit and the investigation of the behaviour of these materials under the expected temperature and irradiation conditions.
11. The examination of the behaviour of special metals, such as zirconium, which might be used in high temperature and high neutron flux regions of the reactor particularly with respect to compatibility.
12. The development of totally enclosed circulating machinery with gas bearings ; the behaviour of these gas bearings in helium atmospheres and possible action of coolant-borne carbon and fission product particles.
13. Theoretical and experimental studies of fluid flow and heat transfer problems in the core and other regions of the primary coolant circuit.
14. The problems of sealing the primary circuit to prevent the escape of fission products. A high standard of leak tightness comparable to that demanded in high vacuum techniques will be required.
15. Methods of processing large volumes of air from the containment vessels or reactor building to remove traces of escaping fission products which might otherwise be released into the atmosphere. This is primarily a question of removing radio-iodine from the effluent air.
16. Development of efficient nuclear-radiation shields capable of retaining their properties at temperatures up to 300 deg. or 400 deg. Cent.
17. Theoretical studies of nuclear physics aspects, kinetics and control problems.
18. Experimental zero energy and exponential studies of the nuclear physics, kinetics and control problems.
19. Development of methods of measurement and instrumentation for high-temperature conditions.
20. Development of certain high-temperature techniques such as the joining of graphite to graphite and the introduction of probes and instruments into very high temperature regions of the reactor.

† Extract from Annex A of the Agreement concerning the high-temperature gas-cooled reactor project.

LETTERS AND LITERATURE

Letters to the Editor

We do not hold ourselves responsible for the opinions of our correspondents)

USING WATER OVER AND OVER AGAIN

SIR,—In the leading article with the above heading in your issue of February 27, you made reference to the paper on "Water Recirculation in Steel Works," which was read in Sheffield on February 20, before the joint meeting of the Institution of Water Engineers, the Iron and Steel Institute and the Sheffield Society of Engineers and Metallurgists. You state that, "by water-works standards, as the authors of the paper on the Park Gate plant remark, the cost of treatment of the water in circulation can prove 'fantastically' high." You then proceed to pose the question: "where in such figures is there any incentive to industry to economise in the demand for water by adopting recirculation?"

As one of the authors of the paper in question, I have to point out that, when referring to costs, the phrase "fantastically high" was used in juxtaposition with the phrase "especially when related to the flow-rate of the raw-water make-up supply." In the case of the rolling-mill installation described in the paper, the flow-rate of the make-up supply is only one-twelfth of the rate of water consumption by the plant served, and the object of the warning regarding treatment costs was to obviate any temptation to regard these costs as being related to the make-up supply, which is not the correct basis of assessment.

Municipal water treatment plants are essentially concerned with treatment for potable purposes, whereas the main purpose of the treatment plant described in the paper is the removal of finely-divided mill scale from the circulated water, after use in the rolling mill. As such, the process is intrinsically associated with operation of the mill. Furthermore, if it had been arranged that the water used in the mill should not be recirculated but discharged to the river as an industrial effluent, it would still be necessary to remove the bulk of the suspended solids from the effluent in order to comply with the requirements of the local River Board. It is therefore incorrect to infer that the costs relating to the treatment process have arisen because a water-recirculation system was installed. Indeed, now that quality-control of industrial effluents is becoming an increasingly significant factor, a recirculation system can cost little or no more to install and run than a once-through system.

The object of the paper was to stress the advantages of recirculation, in the interests of water economy. In the case of the rolling-mill installation in question, due to local shortage of water supply resources, a recirculation system was adopted because it would not otherwise have been possible to build the rolling mill on the preferred site. Nevertheless, it must be stressed that, even if a sufficient supply of water had been available to meet requirements on a once-through basis, treatment of the effluent would still have been necessary to comply with statutory regulations. The paper showed how the requisite treatment can be adapted to allow of continuous re-use of the water. A make-up supply is required only as a consequence of losses by evaporation—partly to replace that loss and partly to control the resultant build-up of dissolved solids in circulation.

It is most regrettable that your misinterpretation should have led you to deduce that the paper provides no incentive to industry to adopt recirculation as a means of meeting water requirements. The authors prepared it with exactly the opposite objective.

IAN M. E. AITKEN,
B.Sc. (Eng.), M.I.C.E., M.I.Mech.E., M.I.E.E., M.I.W.E.
Brian Colquhoun and Partners,
Upper Grosvenor Street,
London, W.1,
March 6, 1959.

STANDARDS MAKING

SIR,—The over-riding factor in deciding to revise B.S. 1574, the subject of a letter by "M.I.Mech.E." in your February 20 issue, was a feeling that here was an opportunity—in the interests of good trading relations—for Britain to come into line with Continental and American practice. It does seem desirable, where international standardisation can be achieved without undue difficulty, to take steps to further this end. Your correspondent "M.I.Mech.E." may like to know that seldom has the revision of a standard given rise to so little argument and what he would term "manœuvring."

The proposal to change the method of dimensioning split cotter pins from over the eye to under the eye was circulated to the committee responsible for the standard with a special covering letter drawing attention to this feature of the suggested revision. The committee included representatives from a very wide field of British industry but no objection was received from any of them. Subsequently, in accordance with our normal practice, the draft was circulated for comment to industry generally, its appearance was announced in *B.S.I. News* and a special item appeared in the issue concerned (October, 1958), again drawing particular attention to this aspect of the revision of B.S.1574. Although all reasonable steps were taken to ensure that this development had received adequate publicity, it is a fact that very few comments were submitted on the draft in general and only one on the method of dimensioning. Even this was hardly in the nature of an objection, merely stating that the correspondent's normal practice was in line with the then current issue of the standard. When advised of the reasons why the change had been introduced, the correspondent did not pursue the matter further.

In reply to your correspondent, we should, therefore, like to say that the committee were neither unaware of, nor indifferent to, the inconvenience which the proposed change might entail. Only when they had taken all the steps in their power to ensure that the implications of this change were realised and had not received notice of any objections, did they finally approve the standard for publication.

C. DOUGLAS WOODWARD
British Standards Institution,
London, W.1,
March 6, 1959.

Book Reviews

Lubrication Science and Technology. Edited by JOHN BOYD. Pergamon Press, Ltd., 4 and 5, Fitzroy Square, London, W.1. Price 105s.

IT is becoming a common practice for certain publishers to arrange to reproduce the proceedings of scientific conferences. These are often issued under the title of the subject and in a format which gives the impression of a work treating the subject as a whole but which in fact consists of a collection of papers each dealing with some specialist aspect. *Lubrication Science and Technology* falls into this category being a compilation of papers and discussions presented at meetings of the American Society of Lubrication Engineers. In fact, it is described by the editor as initiating the publication of the A.S.L.E. Transactions. As such, it is worthy of attention.

The desirability of setting up specialist bodies outside the major engineering institutions is a matter of doubt; the advantage of a forum for specialists being offset by the fact that the results of their deliberations are not automatically brought to the attention of interested engineers in other fields. This is particularly important in subjects such as lubrication which concerns almost all mechanical engineers. The American Society of Mechanical Engineers has a Lubrication group and the two bodies hold one joint conference annually as well as separate meetings. It is a pity that all this material cannot be referred to in one place.

The present volume contains twenty-seven papers covering a wide range of topics. The first five papers are concerned with ball and roller bearings under extreme conditions of use such as are encountered in aircraft gas turbines. Wagner and Burwell are concerned with the search for improved materials for the cage or separator. The materials showing the best wear resistant properties comprised a hard load-supporting phase based on nickel with silicon additions, together with silver as the soft phase. They were most effectively fabricated by powder metallurgy using the infiltration method for adding the silver. Accinelli describes methods of testing grease for operation at high speeds; greases of smooth texture and high consistency were best. The oil phase should be of high viscosity. Diester type oils were best but silicone oils were greatly inferior to mineral oils. Oxidation is the main cause of deterioration of grease under high temperature conditions of operation and Mahnche and Boes describe apparatus in which this factor may be accentuated by operating a bearing in an atmosphere of oxygen. Failure by surface fatigue or pitting is the major factor limiting the lives of bearings themselves. Because of the wide variation in life experienced between nominally

identical bearings, tests have to be replicated many times so that research in this field is very costly. Carter, Butler, Bear and Anderson have therefore developed a rolling-contact fatigue spin rig in which two balls are driven by air jets around the bore of a cylindrical race. Most failures originated in sub-surface shear and closely resembled those obtained in bearings. The relation between stress and life corresponded closely with that obtained with tests on actual bearings and inclusions, changes in metallurgical structure and directional characteristics of the steel arising from manufacture all adversely affected fatigue life. Oils also have an important effect on bearing life. Otterbein shows that ball bearing life increases with increased viscosity but confirms the M.E.R.L. finding that other undefined properties in lubricants also affect bearing life.

The problem of lubricating gears is in some respects similar to that of ball bearings but in others radically different. Thus Davidson and Ku show that pitting occurs in the pitch line region whilst scuffing occurs when the sliding velocity is highest. The initial incidence of pitting does not appear to be correlated with the initiation of scuffing. However, when pitting became advanced, scuffing almost always followed. On the other hand, no evidence was found that severe scuffing could lead to pitting. This paper includes an interesting series of photographs purporting to show the development of scuffing ; these are reproduced on too small a scale, however, to be adequately informative. Gear contact conditions are often simulated, for lubricant test purposes, by rollers running together but at different peripheral speeds. The McKee EP lubricant testing machine is constructed on this principle. White presents the results of tests of thirty-one oils on this machine. Whilst no clear pattern emerges from the data given, the results are held to have been of considerable value in predicting the behaviour of different formulations in service.

The addition of polymer additives to lubricating oils to confer better viscosity-temperature characteristics is becoming common practice. Selby has made a study of the variation of viscosity with shear-rate of these oils and has revealed that their behaviour is somewhat complex. He points out that, in order to obtain good low-temperature performance, base stocks of low viscosity tend to be used. This may lead to an increase in engine wear at high speeds, loads and temperatures. He also sounds a note of caution on polymer degradation.

Radiation damage to lubricants and bearing materials is a hazard to be guarded against in the design of reactors. Damage to organic lubricants is not attributed to the absorption of primary radiation but is due to secondary ionisation caused by neutrons and gamma rays. Indeed, the actual deterioration of the lubricants can be considered as being the result of ordinary physico-chemical reactions initiated by a somewhat extraordinary source of energy.

The use of chromium faced piston rings is now recognised as a good means for reducing cylinder bore wear. However, different oil formulations have been shown by Abowd, using radioactive methods, to lead to different distributions of wear as between piston ring and cylinder bore. This is an important conclusion in so far as piston ring wear alone has often been used to characterise lubricants.

Theory of Friction and Wear is dealt with by Rabinowicz who speculates on the energy balance created when metals come into contact. His treatment is not sufficiently well developed to carry conviction but the results accord reasonably well with experimental data selected from the literature. Experimental studies of the wear of steel, copper, nickel and tungsten carbide in oxygen and argon are reported by Cocks. These confirm the importance of the ambient atmosphere on wear behaviour. Synthetic sapphire is being increasingly used as a bearing material, and Coffin reports a series of experiments in which various metals are used to form the mating surfaces. Here again the effect of the ambient atmosphere is shown to be of importance. Other papers deal with "Wear of Carbon Seals," "Molybdenum Disulphide at High Temperatures," "Machining of Metals," "The Feeding Characteristics of Waste Packed Railway Journals," and "The Hydrodynamic Design of Bearings."

It will have been gathered that the volume contains a great deal of information which the discerning engineer may put to good use. The papers are, however, somewhat ill-assorted although the editor has succeeded in maintaining a generally high standard of presentation and content.

History of Technology, Volume V. Edited by C. SINGER, E. J. HOLMYARD, A. R. HALL, and T. I. WILLIAMS. Clarendon Press : Oxford University Press, Amen House, Warwick Square, London, E.C.4. Price £8 8s.

IT is not at all surprising that the fifth and last volume of this remarkable work should be open to substantially more criticism than the first four. The task the editors and contributors faced in tracing the history of technology from ancient times up to the middle of last century was hard enough. But to carry it fifty years further on within the compass of a single volume—even one running to over 900 pages—and to do so without error or lack of balance was more than could be expected. Engineers need only remember what immense developments there were in their own technology during those fifty years and need only consider what effects engineering developments had upon other technologies to realise how impossible it must be to give a really adequate concise account of them. A whole range of new industrial technologies was being born during the period. Electric power generation was begun, stimulated in part by the appearance of a newly successful prime mover, the steam turbine. Modern methods of steel production were discovered. Oil production and oil refining were begun. The internal combustion engine was developed into a really practical device. (Alas ! The contribution of Akroyd Stuart is once more overlooked, whereas Dr. Diesel's work is amply covered.) The foundations of chemical industries were laid. The technology of aeronautics was developed. The list could be much longer extended, but we will mention only one other technology rooted in the period—photography and, more particularly, cinematography. Additionally and importantly it was during the latter half of last century that science really began to play a larger part in technology so that it became necessary to begin to teach technologies scientifically.

We do not think any engineer could feel wholly satisfied with this, the fifth and last, volume of the *History*. Yet there is no engineer who could fail to be fascinated by it. For the period covered is, in itself, an immensely exciting one. A kind of civilisation never before known in man's history began really noticeably to come into being between 1850 and 1900. Quite rightly, therefore, the *History* is brought to an end by two chapters, "Technology and Industrial Organisation" and "Technology and its Social Consequences." Certainly, if the whole set of five volumes cannot be afforded, engineers should have this, the fifth and last, beside them for reference. Maybe it is not as well balanced as engineers (and no doubt its editors, too) would desire ; maybe there are omissions. But it is easy to criticise. In fact a fine attempt has been made to achieve the impossible.

It remains to offer congratulations to the editors upon the completion of their very productive labours in preparing these five volumes and to Imperial Chemical Industries, Ltd., and the Clarendon Press, Oxford, whose collaboration made the venture possible.

Books of Reference

Kempe's Engineers Year Book, 1959. Sixty-fourth edition. Morgan Brothers (Publishers), Ltd., 28, Essex Street, Strand, London, W.C.2. Price 82s. 6d. Another edition of Kempe's is with us and offers revised information on a majority of the subjects which from time to time engage the attention of the engineer. Three of the seventy-nine sections of the book are revised and rewritten : "Flow Metering and Mechanical Testing" ; "Refrigeration" ; and "Paints and Varnishes." Additions have been made to many other sections, including "Standard Dimensions" (details of Lock Nuts, Lock Washers, Torque Spanners, Fastening Threads, Machine Screws and Machine Screw Nuts, Pipe Threads for Petroleum Industry, Unified Threads, Acme Threads) ; "Machine Tools" (details of Broaching Machines) ; "Iron and Steel" (details of Electric Furnaces) ; "Non-Ferrous Metals and Alloys" (details of High Temperature Nickel Alloys) ; "Lifts and Escalators" (details of Locking Devices for Landing Gates and Lift Doors) ; "Hydraulic Transmission of Power" (details of Automatic Seated Valves, Variable Stroke Pumps, Variable Capacity Fixed Stroke Pumps with Variable Spill, Hydraulic Couplings) ; "Harbours and Docks" (details of Diving Time Limits and Ascent Procedure, Recompression Chambers, Lighthouses, Winker Beacons, Automatic Fog Detectors, Signal Buoys) ; "Fuels" (details of Heat Insulation and Thickness and Cost of Lagging) ; "Gas Engineering" (details of Gasholders, Tower Purifiers, Gasification Plant, Use of Petroleum Products) ; "Foundations and Earthwork" (details of Cast *In situ* Concrete Piles, and Sheet Steel Piling) ; "Clays and Allied Products" (details of Lightweight, Perforated and Highly Porous Bricks, Heat Insulating Materials, Insulation of Furnace Walls) ; "Concrete and Reinforced Concrete" (details of Fire-Resistant and Expanded Shale Concrete, Reinforcing Bars, Design of R.C. Beams). The unquestionable value of this wide range of information must commend Kempe's to all who study or practise a branch of engineering.

The Shipping World Year Book and Who's Who, 1958–59. The Shipping World, Ltd., 1, Arundel Street, London, W.C.2. Price 60s.—This is the seventy-first edition and contains maritime directories arranged in useful and logical form, all of which have been revised and several have been expanded to give greater coverage. The general section lists such items as : bunkering ports ; Acts of Parliament relating to shipping and freight units, and is followed by nearly 240 pages containing the names of the leading shipowners, shipbuilders and marine engineers. A comprehensive statistical section precedes the directory of shipowners and ship managers, which covers tramp and tanker owners as well as liner companies, and is arranged in alphabetical order of countries. A similar arrangement is followed for the directories of shipbuilders, ship repairers, marine engine builders, and towage and salvage contractors, each of which records the main particulars of the firms concerned. Pilotage districts are listed and the details of the various port and harbour authorities of the British Isles are given.

Electrical Engineers' Exhibition

No. 1

The Electrical Engineers (A.S.E.E.) Exhibition is to be opened at Earls Court on Tuesday, March 17, by Lord Brabazon of Tara and will close on March 21. As this year is the golden jubilee of the Illuminating Engineering Society electric lighting will be given special prominence in the exhibition. It is proposed to stage a special demonstration of "Aurama," a form of entertainment combining light, colour, stereophonic sound and animation on the lines of "Son et Lumière" which was introduced at Greenwich Park. More than 430 British electrical firms will be taking part in the exhibition, and some of the exhibits are described below.

Metropolitan-Vickers Electrical Company, Ltd.

A TWO-SPEED change-pole squirrel-cage motor with a novel winding arrangement is an item of unusual interest among the exhibits to be shown by Metropolitan-Vickers Electrical Company, Ltd., Trafford Park, Manchester. Whereas the pole combinations required in a two-speed motor are normally produced by having two separate windings the motor exhibited has a pole-modulated tapped winding—a device invented by Professor G. H. Rawcliffe of Bristol University.* By applying this invention it is possible to design a two-speed motor with a single tapped winding for pole numbers such as 8/10, 10/14, 14/16 or 14/22, but the ratio of pole numbers must not exceed 1·5 (rounded). The motor on show is a 30/15 h.p. machine with 8/10 poles. It has a total of six outgoing leads and is controlled by a standard switch-unit for a tapped-winding induction motor.

Performance at both speeds is generally better than that obtained from a machine having two separate windings. There is stated to be no limit to the size of machine on which the new winding can be used.

Two examples of drip-proof squirrel-cage motors with British standardised dimensions will also be shown. One will be a 10 h.p., 2850 r.p.m., type KN-C215, foot-mounted motor; the other will be a 3 h.p., 1400 r.p.m., type KVN-C 184D flange-mounted motor. The KN-C and KVN-C drip-proof squirrel-cage motors range from 1 h.p. to 40 h.p. at four-pole speeds, with corresponding ratings at other speeds. They have been designed to conform with B.S. 2960/1958 and have Class E insulation permitting a maximum temperature rise of 65 deg. Cent. instead of the previous maximum rise of 55 deg. Cent. for Class A insulation. Moreover, all ratings are on a continuous maximum rating (C.M.R.) basis to conform with the standard which has always applied to totally-enclosed and totally-enclosed fan-cooled machines. These motors are smaller and cost less than type KZ and KVZ ventilated squirrel-cage motors of the same ratings.

* *Proceedings I.E.E.*, Vol. 105, Part A, No. 22, August, 1958.

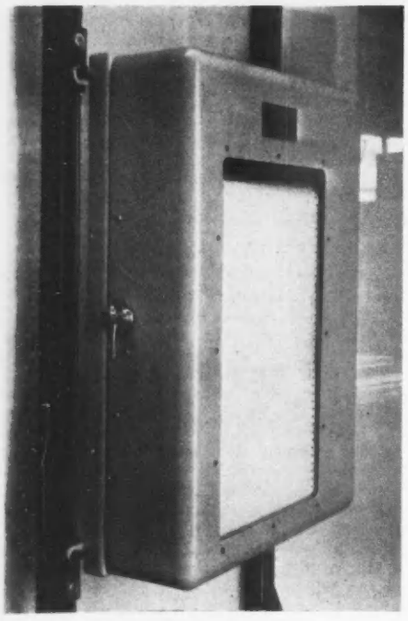


Fig. 1—Mine-hoist chart recorder for wall or panel mounting. It records the number and duration of winds, the winding speed, the decking or changing interval, the starting time and the time for various maintenance operations—Metropolitan-Vickers

One of the new exhibits will be a mine-hoist chart recorder developed to produce a graphic record showing the extent and duration of all movements and standing times of a mine hoist, a requirement that is now a statutory obligation in many countries. The recorder consists essentially of a motor-driven mechanism that drives a chart upon which a single pen records the following information: the number and duration of winds, the winding speed, the decking or changing interval, the starting time and the time taken for operations such as shaft inspection, rope inspection and shaft timbering. When specially required the recorder can also be supplied to record direction of wind. From the graphic record it is possible to detect any delay or failure to operate to a desired time cycle.

The electrically-actuated pen records speed more accurately than mechanical governor-controlled recorders, and is easily detachable for inspection and filling. The record for the previous hour can be inspected through the "Perspex" window and the complete record on the chart can be examined without removal. Only electrical connections are necessary. The recorder can consequently be installed in any desired position without consideration of mechanical drives. It is also designed for either panel or wall mounting (Fig. 1) thus eliminating floor cutting during installation.

The company will also show its portable quick-response d.c. chart recorder developed for immediate recording as an aid to adjustment and testing of control systems and the like in the field and in test rooms. It consists essentially of a constant-speed chart mechanism and two writing elements of the permanent-magnet moving-coil shuttle-mounting pattern. The roll chart is 10cm wide.

Among the larger exhibits will be a type M21 resistor-transition on-load tap changer suitable for use with transformers up to 20MVA, 33kV. It consists of a double-sided selector switch for each phase, the associated diverter switches and transition resistors, operating mechanism and motor driving gear, and is assembled as a single ironclad unit, bolted to the main transformer tank (Fig. 2). The exhibit will have glass covers to allow the mechanism to be seen in operation. Resistor transition ensures minimum arcing at the diverter switch contacts. The diverter switches are enclosed in a separate "drop-down" tank for easy inspection and the contacts have single-bolt fixing and are accessible from the front. Once a tap change has been initiated, it is impossible for the operator to interrupt it. Up to sixteen voltage steps (seventeen positions) can be accommodated in the M21 tap changer.

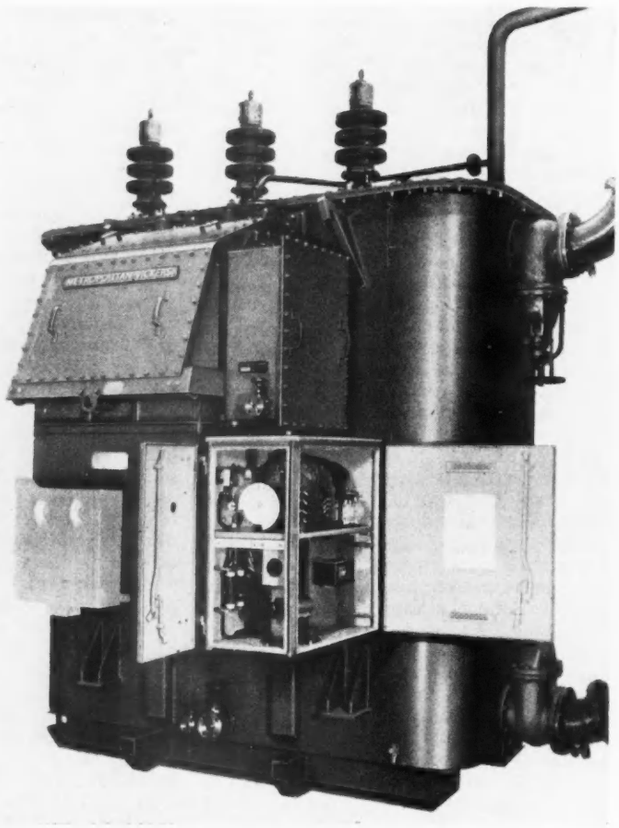


Fig. 2—"M21" resistor-transition on-load tap changer for use with transformers up to 20MVA, 33kV—Metropolitan-Vickers

BRITISH THOMSON-HOUSTON COMPANY, LTD.

A transistor voltage regulator is one of the interesting developments in electronic engineering to be shown by the British Thomson-Houston Company, Ltd., Rugby.

This voltage regulator (Fig. 3) is intended primarily for use with single-unit, self-contained alternators of rating up to 100kVA at 50 to 60 c/s, and it is designed to give automatic control of the alternator voltage to within ±1 per cent of its rated value. The regulator consists essentially of a Zener-diode voltage sensitive circuit, a transistor amplifier, a rectifier supplying the exciter field power, and a stabilising circuit. The voltage sensitive circuit examines the alternator terminal voltage and produces an error signal when the terminal voltage departs from its normal value. This error signal, in turn, controls the exciter field through the transistor amplifier in the correct sense and degree to restore the alternator voltage. Transient negative feed-back of the exciter armature voltage into the amplifier circuit ensures satisfactory damping of the voltage recovery, following load changes. All the components in the regulator circuit are rated to withstand tropical conditions and are not affected by vibration.

The company will also be showing a synchronous welding control equipment for controlling the welding time and current of a spot or seam welding machine : in the case of spot welding, 1–90 cycle heat time in one cycle steps ; in the case of seam welding, 1–9 cycle heat time, 1–9 cycle cool time, both in one cycle steps. Time selection is carried out by positive action switches connected in a digital circuit using " Dekatron " tubes to control and to display the selected times. Heat control is by phase shift and either of

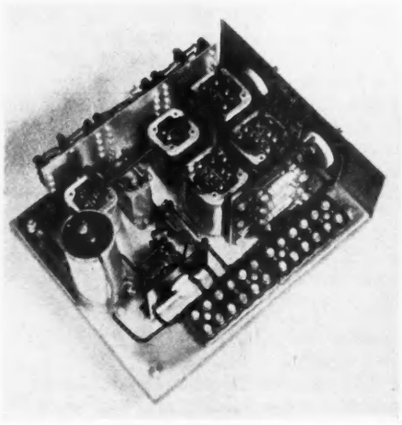


Fig. 3—Transistor voltage regulator with cover removed. It is designed to give automatic control of alternator voltage within ± 1 per cent of the rated value, with alternators up to 100kVA at 50-60 c/s—B.T.H.

two systems may be selected : first, manual current control, with which the required current is selected by the manual heat control rheostat ; secondly, automatic current control with which the required current is selected by the auto heat control rheostat and maintained at a constant value irrespective of substantial changes in load impedance or supply voltage. This equipment is arranged to operate with a series resistance in the supply line to demonstrate regulation with varying supply voltage.

Among the switchgear exhibits will be a three-phase automatic circuit recloser (type RB) for the improved continuity of supply on rural lines up to 11kV (Fig. 4). In con-

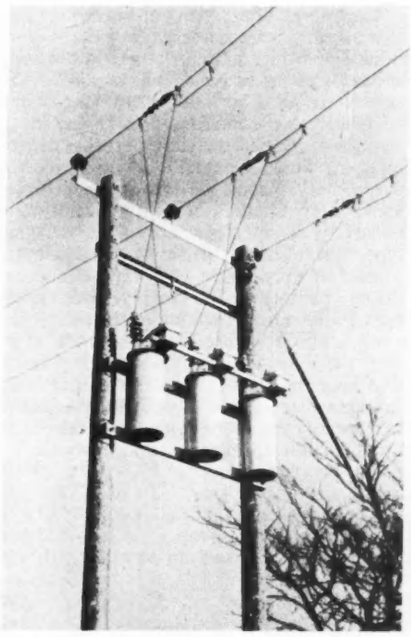


Fig. 4—Three-phase automatic circuit recloser (type RB) for improved continuity of supply on rural overhead lines up to 11kV—B.T.H.

junction with fuses, the automatic circuit recloser gives a degree of service continuity unobtainable with other forms of protection. Its usefulness is based on the fact that approximately 80 per cent of the faults occurring on overhead lines are temporary—that is, the faults are cleared as soon as the lines are de-energised. The recloser prevents such transient faults from causing lengthy interruptions of supply. It opens and clears the fault before associated fuses can blow, and immediately recloses to re-establish supply.

The company also proposes to exhibit, outside the exhibition hall, one of eighteen B.T.H. diesel-electric locomotives being supplied to the New Zealand Government Railways. It is a 40-ton, 400 h.p., double-ended bonnet locomotive with a maximum tractive effort of 22,500 lb and is suitable for shunting and light passenger duties at speeds up to 40 m.p.h. The motive power is derived from two Rolls-Royce diesel engines driving through B.T.H. electrical transmission. The mechanical parts, designed in collaboration with B.T.H., were made by the Clayton Equipment Company, Ltd., in the Hatton, Derbyshire, works, where the final assembly was carried out.

THE GENERAL ELECTRIC COMPANY, LTD.

Advances in lighting and electrical installation equipment will be shown by The General Electric Company, Ltd., Magnet House, Kingsway, London, W.C.2. The display of " Osram " lamps and tubes will include quartz tubular infra-red heaters with ratings of 1kW at 200/250V and 500W at 100/125V. The heaters are designed to have a high resistance to thermal shock and to be suitable for applications requiring a high energy input and a rapid temperature rise of the radiated surface. Applications range from quick grilling in the catering trade to the task of simulating the heating effects experienced by aircraft and guided missiles in supersonic flight.

Amongst the new lanterns for street lighting will be the G.E.C. " Three-Eighty " lantern for " Osram " 5ft, 80W tubes ; it has a body consisting of two die-cast light-alloy end pieces built on to a 9in aluminium alloy extrusion, to form a casing of light-weight, narrow section and great strength. All the auxiliaries necessary to operate the tubes, together with the wiring harness and tube-holders, are carried in the lantern on a quickly detachable die-cast aluminium tray. The lantern combines the new, inclined tapered appearance with an efficient optical system, the light from the tubes being controlled by machined " Perspex " reflector plates designed in the G.E.C. research laboratories.

Visitors will also see the new " Z843OCM " lantern which has been installed along the sections of the Great West Road and Great South-West Road in the Borough of Heston and Isleworth. The lantern has an optical system designed for use exclusively with 250W or 400W " Osram " mercury (MBF/U) lamps. The lantern body is of die-cast light alloy and carries a pressed prismatic refractor bowl made of heat-resisting glass. In use the lamp is mounted with its axis tilted down 5 deg. from the horizontal, and with the plane of the rim of the bowl at about 15 deg. to the horizontal. By arranging the lampholder outside the bowl with the lamp entering at an angle, a small compact unit has been achieved. The slight upward inclination of the lantern towards the roadway directs the maximum amount of light on to the carriageway and the adjacent area on both sides, and enhances the appearance of the lighting units by day. The lantern has been accepted by the Ministry of Transport and Civil Aviation for main road lighting.

The Z9464 side-entry mounting lantern will also be shown. Designed for main road lighting it houses an Osram 140W integral jacket sodium lamp. The lantern body is made in die-cast light alloy and is supplied

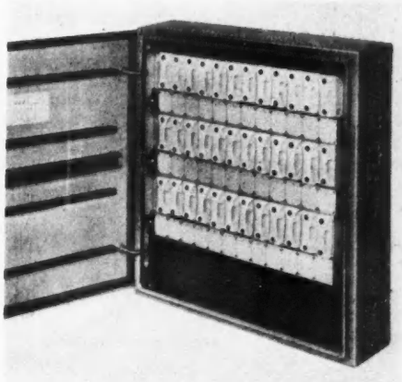


Fig. 5—Hose-proof weatherproof fuseboard with interphase barriers and shielding of live parts and cables—G.E.C.

with all the auxiliaries mounted within the body. Light control is provided by injection moulded refractor plates sealed to each inner side of an injection moulded bowl. Injection moulding provides more efficient light control by highly finished prisms, greater impact resistance and light weight.

A separate stand on the first floor will be devoted to equipment and accessories for electrical installations. One of the new exhibits is a small cubicle switchboard, 90in high, 26in or 30in wide, with a maximum overall depth of 18in or 30in as required. High performance is obtained by using double-break cam-operated switches, each phase being separately housed in a moulded

case of arc resistant material. Each cubicle can be sub-divided into a number of separate compartments by horizontal trays suitable for requirements ranging from two to eight circuit assemblies. The individual units are built to plug in, to simplify maintenance or modification of an existing switchboard and, as front access only is required, the cubicles may be placed back to back or against a wall to save space. The main horizontal busbars at the top of the cubicle are rated at 1200A. Coupled to these are the vertical busbars rated at 600A, and the assembly will withstand a short circuit equivalent to 25MVA at 440V. Busbar and cable isolation plugs are provided, and the compartment doors of the fuse switches are mechanically interlocked. As exhibited, the new cubicle is additionally fitted with a number of motor starter panels, and they too are withdrawable plug-in units.

A new range of hose-proof (HW), dustproof and weather-proof fuseboards (Fig. 5), suitable for all general, commercial and industrial use, particularly in dairies, breweries, hospitals and schools will also be shown. Rewireable fuses suitable for 440V and h.r.c. fuses for working up to 550V, both rated at 20A, are available. The case is made of 14 S.W.G. steel, and all live parts and cables are fully shielded. Interphase barriers are fitted.

There will be a demonstration of a G.E.C. air-pressurised electrical system which makes possible the installation of lighting and other equipment in an atmosphere containing a hydrogen hazard. The company also holds a letter of consent for the use of the equipment where an acetylene hazard is present.

Various systems of busbar and cable trunking will be on show. On the power cable side the 330kV oil-filled cable installation for the Snowy Mountains Hydro-Electric Authority, Australia, will be the subject of a special exhibit. Jointing demonstrations will include the making of cast resin joints on plastics mains cables.

Ferguson Pailin, Ltd.

One of the new equipments shown by Ferguson Pailin, Ltd., Higher Openshaw, Manchester, 11, is the BVP17 single-busbar, air-insulated metalclad switchgear (Fig. 6) which is designed for use on distribution systems up to 11kV. It is of fabricated unit construction, being designed for extension on either side with similar, or other, switch units and oil isolators or switches as required. The unit is arranged for integral earthing, being completely self-contained and having three positions in which the circuit-breaker can be plugged, which eliminates all necessity for special equipment. Busbars and feeder spout safety shutters are independently and positively operated and are of the swinging type, which reduces friction and contributes to ease of operation. They can be independently padlocked to comply with safety regulations during earthing operations.

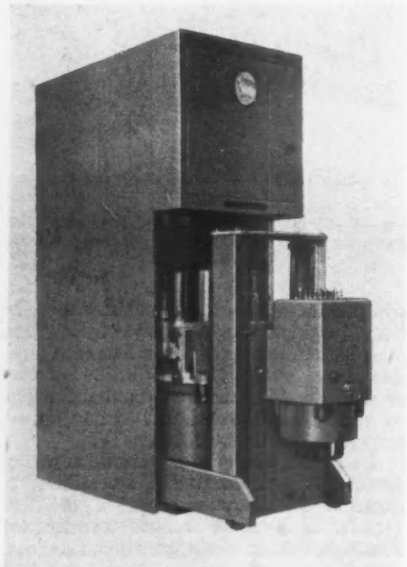


Fig. 6—Single-busbar, air-insulated metalclad switchgear for use on distribution systems up to 11kV—Ferguson Pailin

Each oil circuit-breaker is mounted on its own truck, incorporating an integral raising and lowering device. The truck front comprises two steel sheets telescopically engaged, the upper sheet rising with the breaker and mechanism to form the complete front cover when the circuit-breaker is in the service position.

The circuit-breaker is enclosed in a cylindrical tank, the top plate being of cast aluminium alloy and incorporating a substantial earthing contact. All circuit-breakers are fitted with arc control devices designed to give satisfactory performance when interrupting currents over the whole range up to the maximum short-circuit rating.

The circuit-breaker can be fitted with a direct hand- or spring-assisted, or spring or solenoid type mechanism. These mechanisms are of new design and are interchangeable. A saddle, used with all types of mechanisms, carries the auxiliary switches, secondary plugs and trip coils ; it can be removed as a self-contained unit, eliminating the need to disconnect wiring for inspection and maintenance purposes. Automatic connection or disconnection of the auxiliary circuits is achieved when raising or lowering the circuit-breaker in the service position. Substantial locating dowels ensure correct alignment of the plug and socket boards, whilst individual plugs are flexibly mounted to provide a maximum possible amount of contact.

Another exhibit, the ROP32 oil circuit-breaker, is of improved design for duty up to 33kV, 1000MVA, 1200A and is suitable for outdoor service under all climatic conditions. The circuit-breaker is equipped with spring-loaded, oil-filled bushings, which can be removed without disturbing the current-transformers located under the top-plate. The operating mechanism kiosk houses both electrical circuits and mechanical details, segregated to provide facilities for separate inspection or maintenance in perfect safety to the operator.

There will also be a display of auxiliary products, including rotary and control switches, Butyl insulated current-transformers, epoxy-resin voltage-transformers, instrument switches and high-breaking capacity fuse-links.

Newman Industries, Ltd.

A new range of totally-enclosed motors† from about ½ h.p. to 2 h.p. in frame dimensions complying with B.S. 2048 and NEMA Standard MG1 will be shown by Newman Industries, Ltd., Yate, Bristol. This range of motors is intended to fill the gap that usually exists between fractional horsepower and the smaller industrial motors. More specifically, the ratings are from ½ h.p. to 1¼ h.p. for single-phase capacitor-start machines and ¾ h.p. to 2 h.p. for three-phase machines, the speeds at present available being 1500 r.p.m. (50 c/s) and 1800 r.p.m. (60 c/s).

† See The Engineer, February 6, 1959, page 228.

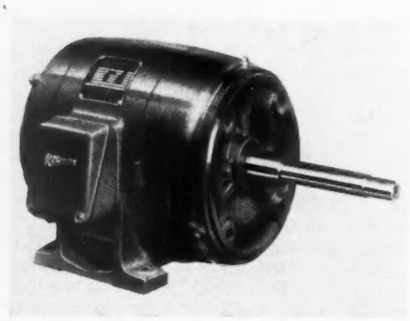


Fig. 7—Close coupled pump motor with drip-proof enclosure. Totally enclosed and flameproof or explosion proof enclosures are also available—Newman Industries

The motor shell is of heavy gauge sheet steel and the two end brackets are of cast iron. The fan and fan cover are of die-cast aluminium. A simple centrifugal switch is fitted in the single-phase motors : the rotating part of the switch is made from interlocking steel pressings with no hinge pins ; the static part has heavy-duty contacts of silver and is enclosed in a dustproof moulded case. All bearings are standard metric sizes and are lightly preloaded for vibration-free running. Cooling air is blown over the outside of the shell by a fan with a protective cowling.

Another new product to be seen on this stand will be a close-coupled pump motor (Fig. 7) which has a NEMA C-type face bracket and a specially designed shaft extension upon which the pump impeller can be directly mounted. As exhibited the motor is in a drip-proof enclosure but the manufacturer states that the motor can be supplied totally enclosed or flameproof or explosion proof, if required.

The company will also show examples of a new range of brake motors (drip-proof or totally enclosed) having a built-in disc-type electromagnetic brake actuated by the normal a.c. supply. Brakes in production this year will provide retarding torques ranging from 2·9 lb-ft to 144 lb-ft, suitable for being incorporated in any of the company's fractional horsepower motors and three-phase motors up to 15 h.p.

Siemens-Schuckert (Great Britain), Ltd.

A flameproof distribution board designed mainly for the oil, chemical and gas industries and others where " hazardous " atmospheres may be present, will be shown by Siemens-Schuckert (Great Britain), Ltd., Great West Road, Brentford, Middlesex. The board comprises flameproof busbar chambers to which are fitted, above and below, a variety of flameproof enclosures, containing, as required, contactors, circuit breakers, switches and fuses, up to 200A rating. Other apparatus, such as star/delta starters, metering equipment and so on, can also be incorporated in the flameproof chambers. Each outgoing circuit is provided with a four-pole isolator in a separate chamber and all covers are fully interlocked. Earth leakage protection of the current balance type can also be incorporated in the incoming circuit or in each individual outgoing circuit.

This company will also show a range of monitored-earth units of various sizes, up to 100A, in sheet steel or ironclad enclosures. The units are applicable to portable tools

and equipment when no permanent static earth can be obtained except by trailing cable. With many portable tools, care is taken to earth them at the time of installation but after constant use, the earth wire may become defective or broken ; this may not be noticed until an earth fault occurs, possibly with serious effect to the operator or to the equipment. The monitored-earth unit ensures an adequate earth path at all times and automatically switches off the supply should the earth wire break or an earth fault occur. The equipments are designed either to trip remote switchgear containing a trip coil, or the units themselves incorporate either a contactor or a circuit breaker. Where a circuit breaker is provided, it contains protection against normal overloads, against short circuits and against unwanted starting after failure of supply. Current balance earth leakage protection is embodied in the units ; it gives adequate protection against earth faults while not being so sensitive as to trip unnecessarily.

GEORGE ELLISON, LTD.

Two new products will be shown by George Ellison, Ltd., Perry Bar, Birmingham, 22b. They are a new air insulated 11kV, 250MVA circuit breaker unit (ASTA certified to B.S. 116 : 1952 and complying with B.E.B.S.-S2) and a new 11kV, 250MVA oil switch unit (ASTA tested to B.S. 2631 : 1955) suitable for service with the circuit breaker unit. Both equipments are illustrated in Fig. 8.

The circuit breaker unit, rated at 400A, has air insulated busbars and current transformers and although only 24in wide, all parts are easily accessible for maintenance. The flush front, designed to eliminate dust traps, gives the unit a clean appearance. The circuit breaker is mounted on a truck for easy withdrawal from the chamber and is vertically isolated by a hand-operated " single " screw mechanism. Gases are discharged direct from the circuit breaker to the rear of the unit. To give long life the high pressure contacts have a parallel wiping action. The contact assembly is oil-immersed in a steel oil tank divided with steel barriers into three separate interphase compartments, each lined with " Elephantide." Four easily-accessible high tensile steel bolts secure the tank. The " butt and wipe " auxiliary plugs are heavily silver-plated. A terminal box for multicore cables for auxiliary circuits is a standard fitting. All busbar and current transformer chambers are made of steel plate and each busbar chamber is individually sealed off when joined to others. The busbars themselves, rated at 1200A, are air insulated and a new brand of " Tufnol " with an epoxy-resin base is moulded separately on to each. They are of unit lengths to simplify installation. For easy access, the terminal chamber for the voltage and current transformer secondaries is situated at the rear of the unit. The air-insulated current transformers are encapsulated. The voltage transformer may be isolated from ground level and padlocked in either the " isolated " or " on " positions. Automatic shutters screen the voltage transformer isolating sockets when in the " isolated " position.

The circuit breaker may be closed manually by a trip-free handle or by charging and releasing a spring, the speed of close being independent of the operator. Closing may also be remote, by releasing a hand-charged spring, by a d.c. solenoid or a lanyard, or the circuit breaker may be power closed with a d.c. solenoid.

Among the safety precautions are mechanical interlocks that prevent the following errors in operation : closing of the circuit breaker except when correctly located in " service," " earth " or " isolated " positions ; lowering of the circuit breaker to isolate when the contacts are closed ; withdrawal of the circuit breaker before it is completely isolated ; raising of the circuit breaker to the service position unless the oil tank is bolted in position. When the circuit breaker is lowered, the live isolating plugs are automatically screened by shutters that are positively driven in both directions.

An easily fixed earthing device may be supplied to " earth " either the cables or the busbars through the circuit breaker.

The new oil switch has a normal current carrying capacity of 400A, a breaking capacity

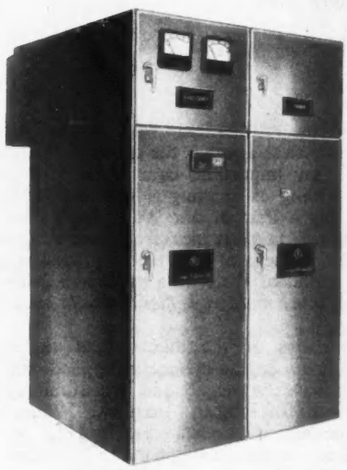


Fig. 8—11kV, 250MVA circuit breaker unit (complying with B.E.B.S.-S2) and oil switch unit. Both equipments are ASTA certified—Ellison

of 400A and a making capacity of 250MVA. It is manually operated by charging and releasing a spring with one movement of the handle, both " making " and " breaking " being independent of the operator. Blade-type, high-pressure line contacts give a single break per phase. Normally the cable box is fitted on the underside, to the rear of the switch. If required, however, a busbar cable box may be fitted to either side of the switch.

The design embodies interlocking arrangements ensuring the following conditions : that the angles of movement from " on " to " off " (or " test ") and from " off " (or " test ") to " earth " are equal ; and that the isolator cannot be moved directly between " on " and " earth " as the handle must be removed in the " off " (or " test ") position and re-inserted in the second position before the second half of the movement can be made. Two padlocks may be provided each having a different key. By fitting both padlocks, the switch may be locked in any of the three positions. If only one padlock is fitted, the movement of the switch is confined to between either " on " and " off " (or " test ") or " off " (or " test ") and " earth."

Plug-in test sticks may be provided. They are incorporated in a triple-pole unit capable of carrying 200A continuously. An interlock ensures that the switch must be in the " earth " position before the test sockets can be exposed and the switch is then locked in this position until the test sticks are inserted. With the sticks in place, the switch is free to move from " earth " to " off " (or " test ") the sticks being locked in position until moved back to the " earth " position. An interlock ensures that the claws that restrain the test stick cannot be moved by hand in order to defeat the interlock.

SMITHS INDUSTRIAL INSTRUMENT DIVISION

A calibrated relay will be one of the new products shown by Smiths Industrial Instrument Division, Chronos Works, North Circular Road, London, N.W.2.

This instrument is designed to operate within very close tolerances at a predetermined voltage or current. Circuits have been devised using two basic versions of the relay, depending on whether the voltage or current to be controlled is rising or falling ; in each case a pair of contacts closes with a positive action, and a high contact pressure is obtained by use of a patent magnetic lock. Typical applications for the relay are engine starter isolation and overspeed protection, overspeed and underspeed warning, close differential apparatus and machine tool overload, protection.

The main design characteristics of the calibrated relay are the accuracy of ± 1 per cent under static conditions, and the low power input (approximately 30 milliwatts). The $\frac{1}{8}$in clearance between contacts, except at closure, eliminates the possibility of contact closure due to vibration. Contact pressure is high, between 15g to 60g, and the accuracy of setting is not adversely influenced by contact wear. The contact compartment is protected by a transparent cover to exclude dust, and ensures a reliable performance under vibration and stress.

The display will also include a number of servo-motors. of which the size 11, 50 c/s, two-phase 26V motor is typical.

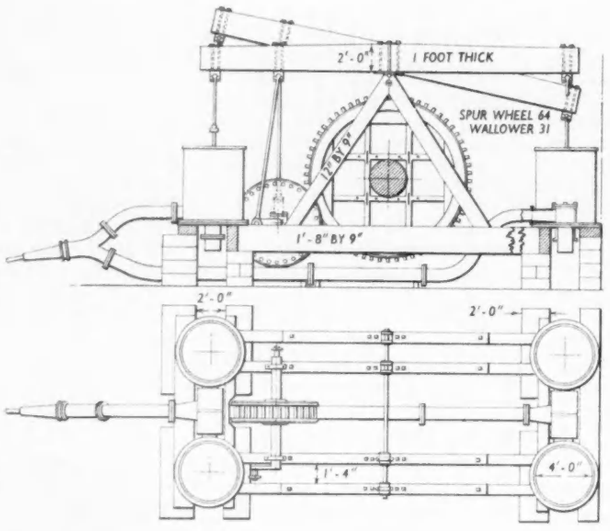
In the latest designs of Smiths servo-motors the conductors are of aluminium to reduce inertia and are cast into the rotor slots. The stator windings and body are fully encapsulated in synthetic resin and the rotor tunnel is then bored out, leaving the bore completely smooth, and enabling the air-gap to be reduced, which results in high torques. Miniature ball races are used and with the body are completely housed in a case of laminated stainless steel, a construction which gives good resistance to shock loading and extremes of heat and humidity.

Another exhibit is the " 5AF " ultrasonic flaw detector, a single-frequency instrument available for $1\frac{1}{4}$, $2\frac{1}{2}$ or 5 Mc/s operation. A specially developed amplifier is incorporated to give optimum performance when used with probes having single, twin or common transmitter receiver transducers. This facility for permitting all three normal methods of manual ultrasonic examination to be applied enables complete investigations to be made, and simplifies ultrasonic inspection procedures. This instrument can be used with a two-channel flaw alarm for semi-automatic inspection techniques, or used in conjunction with a depth and thickness gauge. The sensitivity of the instrument is stated to be such that, depending upon application, probe and operation conditions, defects of the order of a $\frac{3}{64}$in (1·19mm) flat bottom hole at $\frac{1}{10}$in (2·54mm) from the top surface can easily be detected. A well-defined trace, extending over the full width of a 3in (7·6cm) cathode-ray tube can be seen clearly under normal conditions of ambient lighting. The total power consumption is 150VA on 50–60 c/s supplies of 100–125V to 200–250V adjustable in 5V steps. The weight is 28 lb (12·7 kg).

(*To be continued*)

Horsehay Blast-Furnaces

At a meeting of the Newcomen Society in London on Wednesday, a paper entitled "The Coalbrookdale Group Horsehay Works," was presented by Dr. R. A. Mott. It deals mainly with the Horsehay furnaces, which were sited near to ironstone reserves and other raw materials available in the eighteenth century in the neighbourhood of Wellington, on Watling Street. The Horsehay Furnace Company was formed in 1753 by Abraham Darby II (then senior partner in the Coalbrookdale Company) and Thomas Goldney II. We reproduce here the section of Dr. Mott's paper which describes the blowing of blast-furnaces.



TO-DAY turbo-blowers are necessary to meet the requirements of a weekly production of 10,000 tons of pig iron as made, for instance, in one furnace at Scunthorpe, Lincs (Appleby Frodingham Steel Company), or Margam (Steel Company of Wales). For most of the nineteenth century, cylinder blowers were used ; these were a refinement of that first developed and operated at Willey furnace, Broseley (Salop), using a Boulton and Watt (B. and W.) steam-operated beam engine. This was probably only the third B. and W. engine built and its application was due to the initiative of John Wilkinson, who recognised the merit of the economy of the B. and W. engine compared with the Newcomen engine, which had hitherto been used chiefly at collieries where the low price of coal made its high fuel consumption unimportant. Many statements which have been made about the blast requirements for burning coke can be shown to be incorrect by a few simple calculations. The volume of air required to burn 1 lb of dry, ash-free coke completely, i.e. to carbon dioxide, is 150 cubic feet; since in a blast-furnace the carbon dioxide is reduced to the monoxide, only half this quantity of air is required at the tuyeres to burn the coke. By calculating the amount of carbon monoxide required to reduce the ferrous oxide, it can be shown that, if this could be carried out with the theoretical requirements (which, in practice, it cannot), the air requirements would be only 25 cubic feet per minute to make 6 tons of iron per week. To allow for the fact that carbon monoxide is not all used and most passes out of the top of the furnace, it may be assumed that 100 cubic feet of air per minute are required.

With bellows 18ft by 4ft depressed 6in by the tappets on a shaft, operated at 16 r.p.m. by a waterwheel, and depressing only one bellow per revolution, the air supply would be 180 cubic feet per minute, so that if this speed of the waterwheel could be maintained, there would be no difficulty in supplying air for a production of up to 10 tons of iron per week. It was deficiency of water supply in the summer that led Richard Ford I, in 1733, to use a horse-gin pump to return the water to the pool for re-use. It was not until 1742 that Abraham Darby II replaced this horse-gin pump by a Newcomen engine. Surprise may be expressed that the Dale Company, which had made cylinders for Newcomen engines for colliery pumping, should prefer a horse-gin, but at that early period Newcomen engines were small and inefficient. Raistrick, who quotes from Ford's letters about "the horse-gin pump," omits an important comparison : "been Contriveing & Erecting a Machine for Discharging a Part of our Water back into ye Poole wch in great measure I have Perfected . . . by ye help of one Horse it Discharges near 2 hhd of Water in a minit *wch is above half as much more as ye ffier engine in Madeley Wood.*"[1]

Estimates of the diameter of the new Newcomen engine cylinders supplied can be made from the weights and by assuming that they were 10ft long and 1in thick. From such calculations it appears that in 1733, when Ford erected the horse-gin pump, a cylinder of more than 30in diameter had not been made and that those of the 1720s were of only 24in or even 15in diameter. The first cylinder of 42in diameter seems to have been made in 1734 and cylinders of similar diameter were still being supplied in 1748. However, in the first engine for the Horsehay furnaces the diameter was 48in and in the second one 60in. The Horsehay development marks the use of large cylinders of much greater power than was available to Richard Ford in 1733 or 1742, and these more powerful Newcomen engines were used with waterwheel and bellows and (probably) with direct pumping of the water on to the waterwheels. Raistrick has surmised from the persistent charge in the Horsehay Accounts for "Tending the machine" that Horsehay used a "blowing machine,"[2] but this is incorrect in implying the use of cylinder blowers. In fact, most accounts of the blowing of blast-furnaces before the use of cylinder blowers and the B. and W. engine became standard are garbled. Cylinders with a piston had been used before they were adopted by John Wilkinson at Willey in 1776. A Swedish visitor observed that they were in use at Crowley's Swalwell forge in 1749.[3] In 1757 Isaac Wilkinson, father of John, took out a patent for cylinder blowers in which an iron cylinder, water sealed, was operated in a wooden tub, three units being operated by a waterwheel,[4] and in the lease of the Dowlais furnace in 1759 Isaac Wilkinson, one of the partners who were to use the invention, was to receive £50 if the production exceeded 20 tons per week.[5] John Wilkinson is supposed to have been using at Willey a version of his father's design, with a Newcomen engine with a 49in cylinder, before he applied to it a B. and W. engine in February 1776.[6]

The chief problems in the use of cylinders were probably the sealing of the piston and the satisfactoriness of the valves. John Smeaton is sometimes credited with the introduction of "cylinder bellows," but he was perhaps the first competent engineer to resolve the problems of design ; he applied his solutions to the Carron furnaces, but the dates of introduction are usually given incorrectly. Carron No. 1 furnace was not blown-in on January 1, 1760, as is often asserted, for "hearth stones had not received in time nor the bellow boards and axle trees yet procured," and it was necessary to find employment for the Coalbrookdale founder (Peter Price), "which must be by erecting an air furnace in the place where we purpose to build the bellows furnace."[7] The blast-furnace was not blown-in until Christmas Day, 1760, and was bellows operated. John Smeaton was not called in until later, and he produced his first plan for a blowing engine for No. 1 furnace in 1764. Smeaton proposed four cylinders operated with double beams by a gear wheel and cranks on the waterwheel shaft, as shown by our title illustration. For No. 3 furnace, two cylinders were used and the first design for No. 1 furnace was altered to match this in 1768, the gear wheel being in cast iron, and in 1769, when the shaft of the waterwheel broke, Smeaton recommended a cast iron shaft ; this was not done until 1770–1, when No. 3 furnace was built on this plan.

The problems of using more powerful blowing apparatus at Horsehay were being tackled before Smeaton was advising on the problem at Carron. They were resolved at Horsehay, so far as production of at least 20 tons of iron per furnace week is concerned, at least as early as at Carron, by the combination of large Newcomen engine cylinders in duplicate for each furnace, but necessarily at a high cost for engine coal. That the Horsehay solution was satisfactory is shown by the fact that it was not until 1800 that a Watt engine replaced one of two blowing engines there, the other (modified) Newcomen engine being still in use in 1830. We must first show what, in fact, was done. Table I gives the amount of leather pur-

TABLE I—*Leather Used at Horsehay Works* (1767–73)

Year	No. of hides	Mean weight (lb)	Total weight (lb)
1767	12	33·2	398
1768	10	32·8	328
1769	12	41·9	503
1770	6	47·0	282
1771	24	42·3	1014
1772	12	48·0	576
1773	24	29·4	709
Average	14·3	38·1	544

chased at Horsehay for the years when two furnaces were in operation.

There was a regular purchase of leather in the period, the average annual purchase being 544 lb. In the period 1741–48 the average annual purchase at Coalbrookdale was 517 lb, which is similar, and the practice may be considered to be the same. The leather was usually described as " butt," and occasionally as " bulls." The weight per hide is less than at Coalbrookdale and probably represents the purchase of smaller, but thicker, pieces. The duo-decimal tendency shown in the number of hides purchased suggests a regular pattern of replacement.

Horsehay had no stream like the Cole Brook, rising some 500ft above the works and draining several square miles, but a pool with a minute feeder ; the Horsehay furnaces were, in effect, dependent on a static pool of water. Raistrick suggests that the Newcomen engines pumped the water which had passed over the waterwheels back on to the wheels (as Smeaton did later at Carron) instead of to the pool (as had been the practice in the Dale), a step likely at a site more level than the Dale. Attention has already been drawn to the bigger cylinders used at Horsehay, but the number of engines supplied is also quite surprising. Table II gives details of the cylinders supplied over a short period of time, and the pump barrels and boiler plates supplied in the same period. The first two entries refer to Horsehay No. 1 furnace, started May, 1755, and the next two to Horsehay No. 2, started May, 1757. The two 24in diameter pumps put in for No. 1 were large compared with those currently used in mining practice and the two haystack boilers may be estimated to have been of 8ft diameter. For No. 2 furnace the cylinder was still bigger but there was only one pump and one cast iron boiler ; the two pumps of June to October, 1758, probably replaced the single pump first installed, and the two boilers probably replaced the cast iron boiler.

The supply of four cylinders in 1770 probably means that two cylinders of smaller stroke were used per furnace, probably to obtain more rapid movement of the pumps. The charges at the fire engine before 1771 were for four men but, subsequently, nine or ten men were employed there. The quantity of coal used for the fire engine is given for each four-weekly period ; the aggregate shows that from 70 to 90 tons per week were used in 1767–70 and 120 to 140 tons per week in 1771–73, which is in agreement with the increase in labour, size of boilers and the steam requirements for two fire engines per furnace. In the records for 1755–61 the coal was not specified for the fire engine but for general charges ; the aggregate was 34 tons per week in 1755–56, when only one furnace was operating, and 60 to 90 tons per week in subsequent years, which is in agreement with the usage for the fire engine during 1767–70. Per ton of iron made, this amounted to 2 to 3 tons of coal in 1755–61, about 1·5 tons in 1767–70, and 2·5 tons in 1771–73. Thus, the consumption of coal in the fire engines was a considerable proportion of the total, but it did enable each furnace to produce 25 tons of pig iron per week, or over 1200 tons per year, a rate not hitherto achieved on so lean an ore.

The blowing arrangements at Horsehay from 1755 to at least 1774 were probably similar in principle to those at Madeley Wood furnaces which were built by Abraham Darby III, it is usually thought, in 1776, when he had acquired the Manor of Madeley. In 1781, Boulton and Watt produced designs for B. and W. engines for Madeley Wood and Coalbrookdale blast-furnaces (James Watt to William Reynolds, January 2, 1781), no doubt similar to that erected at Willey in 1776. A B. and W. engine had already been erected at Ketley furnaces in 1778 ; this, Watt recorded, had a duty of 310,000 cubic feet of water raised 1ft per hundredweight of coal used, compared with 123,400 cubic feet of water raised 1ft per 1 cwt of coal in the old, so that the B. and W. engine gave a reduction of the coal consumption to about one-third of that of the old engine for the same duty. It is probable that these proposed B. and W. engines were put in but, although B. and W. rotative double-acting engines were put in Horsehay forges and rolling mills in 1784, it was not until 1800 that the Horsehay furnaces were stopped to " alter engine to Watts." It is known that, about the period 1780–90, the Coalbrookdale group was experimenting with the Hornblower, Heslop and Sadler two-cylinder engines. A Newcomen engine built for Handley Wood (Derbyshire) in 1776, is illustrated by Raistrick,[2] although he suggests that the " pickle pot " condenser was added later. Raistrick also illustrates a Newcomen engine with cylinder blowers and a water regulator used for blowing Hollin Wood furnace (built by William Reynolds) in 1793. This illustration is No. 36 of William Reynolds' note book ; since at this period (*c.* 1790) Ketley, Coalbrookdale and Madeley Wood furnaces had B. and W. engines, No. 41, which is unlabelled, may be Horsehay furnace. The water regulator was the means of obtaining a steady blast from one blowing cylinder (instead of Smeaton's multiple units), and had been introduced by John Wilkinson at least as early as February, 1776.

TABLE II—*Newcomen Engine Cylinders, Pumps and Boilers Supplied to Horsehay*

Date	Engine cylinders			Pump barrels			Boiler plates			
	Diameter (inches)	Length (feet)	Weight (cwt)	Diameter (inches)	Length (feet)	Weight (cwt)	No.	Weight (cwt)	Weight per plate (lb)	Supplier
September, 1754, to February, 1755	47½	10	72·0	24	10	26·2	127	33·7	32	Wm. Hallen
	—	—	—	24	10	26·2	111	31·8	32	Wm. Hallen
June, 1756, to February, 1757	60*	10	72·2	27½*	10	32·0	C.I. boiler	70·2	—	—
	60	10	107·5	—	—	—	—	—	—	—
June to October, 1758...	—	—	—	—	—	48·2	165	50·0	34	Wm. Hallen
	—	—	—	—	—	48·2	211	68·0	36	Wm. Hallen
January to February, 1770	54	7	49·7	—	—	—	131	50·5	43	Dale Co.
	54	7	43·2	—	—	—	290	86·8	34	Titton forge
October, 1770	—	—	40·0	—	—	—	—	—	—	—
October, 1770	—	—	39·8	—	—	—	—	—	—	—
January, 1771	—	—	—	—	—	—	22	9·0	46	Dale Co.
October, 1772	—	—	—	—	—	—	—	60·2	—	—

* Returned 1761.

REFERENCES

[1] Richard Ford Letter Book (S.L. MS.3190), entry for June 1, 1734.
[2] A. Raistrick, *Dynasty of Iron Founders*. Longmans Green, 1953.
[3] S. Schröderstierna, *Kurogliga Biblioteket*, MS. X, page 303 ; English translation by M. W. Flinn, *Edgar Allen News*, August, 1954.
[4] Spec. No. 1713, March 12, 1757 ; H. W. Dickinson, *John Wilkinson* (Ulverston, 1914).
[5] J. Lloyd, *Old South Wales Ironworks* (London, 1906), page 28.
[6] H. W. Dickinson and R. Jenkins, *James Watt and the Steam Engine* (University Press, Oxford, 1927), page 245.
[7] A. N. Bogle, *The Founding of the Carron Ironworks*, 1759–61 (Falkirk, 1898). (Based on letters of the Cadell family), page 26

Cargo Liner S.S. " Benloyal "

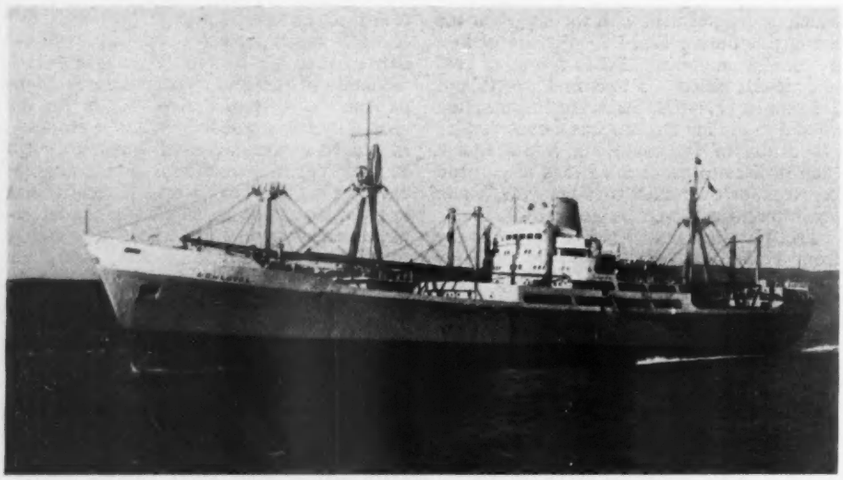
The first of a new class of cargo liners has been delivered by Charles Connell and Co., Ltd., to Ben Line Steamers, Ltd., and is a high-speed ship capable of maintaining 19 knots in service. A deadweight of 10,962 tons is carried and propulsion is by a set of Rowan-Pametrada double-reduction geared turbines of 14,000 service shaft horsepower at 105 propeller revolutions per minute.

A FAST cargo liner of new design recently joined the fleet of Ben Line Steamers, Ltd., and has sailed on her maiden voyage in the company's service to the Far East. The ship, named " Benloyal," was built at the Scotstoun yard of Charles Connell and Co., Ltd., and engined by David Rowan and Co., Ltd., and the following are the principal particulars.

Length overall	549ft 5in
Length between perpendiculars ...	505ft
Breadth moulded	71ft
Depth moulded to upper deck ...	44ft 6in
Draught loaded	30ft
Deadweight	10,962 tons
Gross tonnage	11,463
Net tonnage	6,516
Bale capacity	674,810 cubic feet
Service speed	19 knots
Propelling machinery	14,000 service s.h.p.

The high service speed adopted entailed the development of a hull having fine lines and a low block coefficient and the final form was adopted after the completion of tests, in the tank at Teddington, designed to produce the most efficient lines commensurate with sea kindliness. The superstructure is streamlined and combined with a funnel of aerofoil section, the whole being designed to eliminate the soot nuisance, and was specially tested in the wind tunnel at the N.P.L. Our illustration, overleaf, shows the ship on trials during which performance confirmed tank predictions.

The ship is of all-welded construction, having corrugated transverse bulkheads, there being two complete decks with a third deck forward of the machinery space and an oil-tight flat aft. There are six holds, four forward and two aft of the engine-room, and cargo space in the forecastle and the poop. Refrigerated cargo is carried in the wings of No. 4 lower 'tween decks. Three tanks are provided for latex, while there are four compartments to take edible oils, all seven tanks, with a capacity of about 1140 tons, being available for dry cargo. It is of interest to note that the tanks are not fitted with heating coils and that temperature control is maintained by a steam heater in combination with a " Mono " pump which circulates the oil through the heater. All weather deck hatches are equipped with MacGregor watertight steel hatch covers: the cargo spaces are ventilated by the Thermotank " Drikold " system and protected against fire by a Kidde-Rich carbon dioxide fire extinguishing and smoke detecting system. Separate air heating and circulating systems are fitted for the refrigerated cargo spaces and the four edible oil tanks.



Fast cargo liner S.S. "Benloyal" on trials

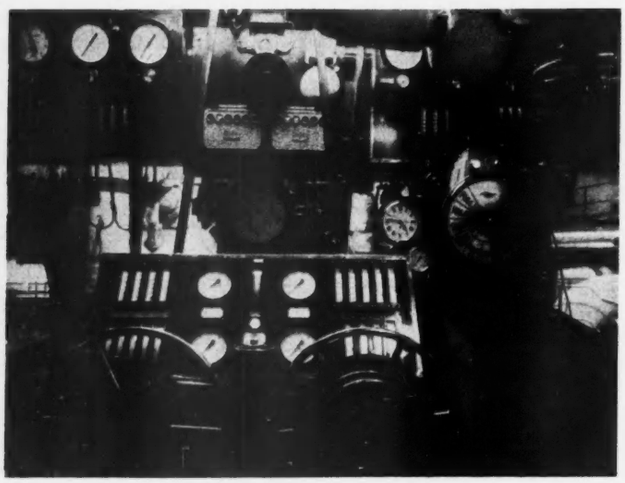
L. Sterne and Co., Ltd., has supplied two fully automatic "Arcton 6" refrigerating plants powered with Higgs motors and able to maintain a temperature of 0 deg. Fah. under tropical conditions. For the domestic refrigerated stores there are three machines provided by J. and E. Hall, Ltd.

Deck machinery and cargo handling equipment includes a 75 h.p. Clarke Chapman electrically-driven windlass to handle 2½in "Tayco" stud link chain anchor cables and two bower anchors, each of 103½ cwt. For dealing with the cargo there are two heavy lift derricks, one of 70 tons capacity at the foremast and the other to lift 50 tons at the main mast, both masts being of self-supporting bipod design. Most of the hatches are served by two 5-ton and two 10-ton derricks, the total complement being ten 10-ton and ten 5-ton derricks, together with two 5-ton electric luffing cranes, having a 45 h.p. motor to drive the winch barrels, a 20 h.p. topping motor and a 16 h.p. slewing motor, manufactured by Stothert and Pitt, Ltd. Laurence Scott and Electromotors, Ltd., supplied the winches, the total including fourteen 3-ton units with 37½ b.h.p. motors, four 5-ton units each with an additional geared barrel and powered by 57 b.h.p. motors, and two 5-ton warping winches on the poop with 44 b.h.p. motors. Steering is effected by an electric-hydraulic four-ram telemotor controlled gear supplied by Brown Brothers, Ltd., while the Marconi International Marine Communication Company, Ltd., has provided the navigational aids.

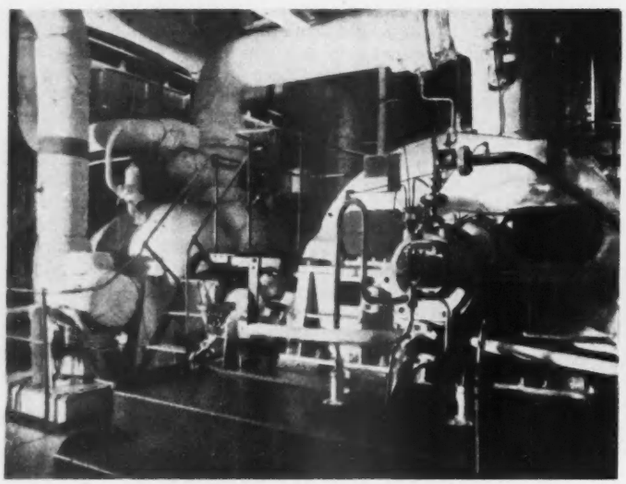
A crew numbering sixty is carried and also ten passengers, and the former all have single cabins. The petty officers, stewards, seamen and Chinese crew are located within the long bridge on the upper deck, together with individual messes and a recreation room. On the bridge deck are located the cabins for the engineers, including a suite for the chief engineer, and the deck officers, with a dining saloon for officers and passengers at the aft end of the house. For the passengers there are four double and two single-berth cabins, each with separate showers, and a small lounge on the boat deck at the aft end of which is a spacious smoke room. Above is the captain's bridge with a suite for the captain and cabins for the chief officer and pilot. Four 24ft plastic lifeboats are carried in Welin Maclachlan davits; three boats have a capacity for forty-three persons, while the fourth, fitted with a motor, takes forty-one persons. All the accommodation is mechanically heated and ventilated on the "Thermotank" system and the same company has fitted its air conditioning system.

Machinery

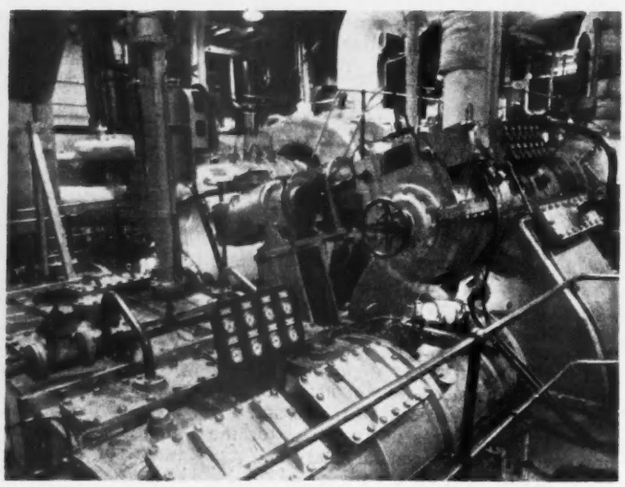
The machinery consists of a single set of double-reduction geared turbines of Pametrada design, manufactured by David Rowan and Co., Ltd. They are designed to develop 14,000 s.h.p. in service at 105 propeller revolutions per minute and to have a maximum output of 15,500 s.h.p. The h.p. ahead turbine has fifteen rows of impulse blading and develops 7196 s.h.p. at 3970 r.p.m., while the dual-flow l.p. ahead turbine has eleven rows of blading in each half and develops 6804 s.h.p. at 3714 r.p.m. Astern power of about 8400 s.h.p. is available and is provided by a two-row h.p. impulse wheel, housed in a separate casing overhung at the forward end of the h.p. ahead turbine, and a two-row l.p. impulse wheel incorporated in a separate casing in the l.p. ahead turbine. Both sets of turbines can be seen in our illustration. The Fairfield Shipbuilding and Engineering Company, Ltd., manufactured the double-reduction, articulated gearing seen in the accompanying illustration. The drive is through a Michell



Engine control console



Looking aft in engine-room showing h.p. turbine (left) and l.p. turbine (right)



Engine-room, with double reduction gearing and turning gear in the foreground

thrust block and the shafting is carried on Michell bearings, and the "Novoston" propeller has a diameter of 20ft by 20·4ft pitch and a developed area of 182 square feet.

Incorporated in the arrangement is a G. and J. Weir closed-feed system consisting of a double-flow condenser of 13,000 square feet surface area, and underslung from the l.p. turbine a closed-feed controller, a three-stage air ejector, two condensate extraction pumps, a feed heater, drain cooler, two turbine-driven centrifugal boiler feed pumps and two auxiliary feed pumps. Other engine-room auxiliaries include a number supplied by Drysdale and Co., Ltd., namely, two condenser circulating pumps, two diesel generator salt water circulating pumps, three lubricating oil service pumps, one diesel oil transfer pump, also ballast, fire and bilge and general service pumps. Drysdale and Co., Ltd., has also installed its fresh water and sanitary water "Pneupress" systems. Associated with the lubricating oil system are Auto-Klean strainers and Serck coolers and DeLaval purifiers. Adams Hydraulics, Ltd., provided the sewage systems and the oily water separator was manufactured by J. H. Carruthers and Co., Ltd., while compressed air is supplied by Reavell machines.

Steam is generated at 600 lb per square inch and 850 deg. Fah. by two Babcock and Wilcox integral furnace selectable superheat boilers fitted with Babcock stud tube and also Green-Foster economisers. They burn oil fuel under a system of forced and induced draught, for which purpose there are installed two Howden forced fans equipped with "Weldex" bled steam air heaters. Each fan is driven by a 27 h.p. motor and rated to deliver 22,500 cubic feet of air per minute against a head of 5·7in water gauge. Two Howden induced draught fans are mounted in the casings and each, driven by a 70 h.p. motor, deals with 36,000 cubic feet of gas per minute against a pressure drop of 5·25in water gauge. Babcock and Wilcox oil fuel burning equipment is installed. All instruments for turbines and boilers are mounted in a single console, which we illustrate herewith.

Auxiliary steam for domestic purposes is supplied at 100 lb per square inch by a Weir steam/steam generator when at sea and by an oil-fired vertical Cochran boiler when in port.

Most of the auxiliaries are driven by electric motors and power for this purpose and the ship's services is provided by four 200kW Allen generators, each driven at 500 r.p.m. by a Mark 5VEBZ Ruston and Hornsby diesel engine. The switchboard, of dead-front design, was supplied by H. T. Robertson and Co., and is mounted on a flat to starboard.

Obituary

FRANK TWYMAN, F.R.S.

We record with regret the death of Mr. Frank Twyman, which occurred last Friday, March 6, in London. He was an authority on industrial spectrochemical analysis and spent the bulk of his distinguished professional career, extending over sixty years, with Adam Hilger, Ltd., and its successor, Hilger and Watts, Ltd.

Frank Twyman was born at Canterbury in

Frank Twyman

1876 and received the early part of his education at the Simon Langton School in that city. From there he went on to study, as a Siemens scholar, at the City and Guilds Engineering College. For a short time after the completion of his course at the City and Guilds, Mr. Twyman worked for a firm manufacturing telephone cables. It was in 1898, when he was twenty-two, that he was engaged by Otto Hilger, who was working in London on the development of spectroscopic instruments. At that time, Professor Michelson, of Chicago University, was investigating the fine structure of spectral lines by means of an echelon diffraction grating. Frank Twyman persuaded Otto Hilger to let him make one of these gratings, a task which he satisfactorily accomplished.

Otto Hilger died in 1902 and his business was incorporated under the title of Adam Hilger, Ltd. Mr. Twyman was appointed managing director, which position he occupied until 1946 when, following amalgamation with E. R. Watts and Son, Ltd., the company was re-constituted as Hilger and Watts, Ltd. Mr. Twyman continued as a director until 1952 and since then had acted as the company's scientific adviser. Throughout this long period of service, Mr. Twyman devoted himself to the design and production of practical spectroscopic apparatus intended for industrial use and not solely for the use of the academic investigator. His work was fittingly recognised by the award of the John Price Wetherell medal of the Franklin Institute and the Physical Society's Duddell medal, and by his election, in 1924, as a Fellow of the Royal Society.

W. CYRIL WILLIAMS

The British locomotive industry has lost one of its distinguished members by the death of Mr. W. Cyril Williams, which occurred on March 5 at the age of sixty-nine. He was a director and former sales director of Beyer Peacock and Co., Ltd., and was a past president of the Institution of Locomotive Engineers. Mr. Williams began his railway work in 1906 with an apprenticeship to the Natal Government Railways where his training, apart from the general workshop course, included running shed, signal department, footplate and drawing office experience. He attended the Durban Technical Institute and obtained the Abe Bailey Scholarship in 1909, the James Brown Exhibition in 1910 and the Institute scholarship in 1911. For a short period in 1912 Mr. Williams was a lecturer at the Durban Technical Institute, and in the following year was appointed a junior engineer to the chief superintendent of motive power at Johannesburg.

After army service throughout the first world war, Mr. Williams went to the U.S.A. and Canada in 1919, on behalf of the South African Railways, where he was responsible for the inspection of locomotives, wagons

W. Cyril Williams

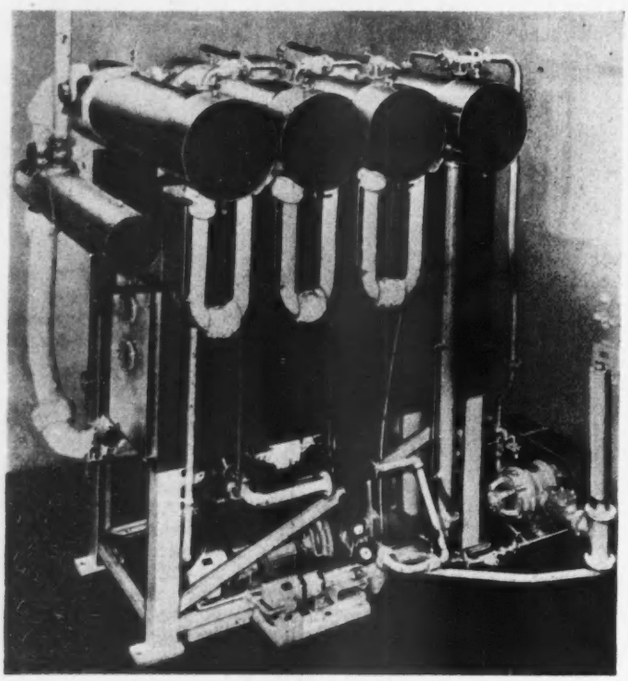
and other railway equipment. After one year there he came to London and acted for a short time as advisory engineer to the South African Railways. Subsequently he returned to duty in South Africa on the staff of the assistant general manager in Durban. Up to the year 1923 Mr. Williams was principally engaged on special engineering test duties, in particular with locomotive performance, and was associated with the early tests of the Garratt articulated locomotive.

In 1923 Mr. Williams joined Beyer Peacock and Co., Ltd., and returned to this country as the firm's London representative. As such he was a pioneer in the promotion of British export trade in locomotives, and was an enthusiastic advocate of the advantages to be obtained by the introduction of the Beyer-Garratt articulated locomotive. In due course he was appointed sales director of Beyer Peacock and Co., Ltd., and in 1945 was elected to the board. During the second world war his wide experience and knowledge of overseas railways was freely drawn upon by the War Office and the Ministry of Supply, and he actively participated in the work of his company on armament and locomotive production for the war effort.

Over the past thirty-one years Mr. Williams had travelled on railways in all parts of the world including the whole of the African continent and the South American continent. He contributed several papers to the Institution of Locomotive Engineers which he served as president in 1949–50. He was also an Associate Member of the Institution of Civil Engineers, a Member of the Institution of Mechanical Engineers and a Member of the Institute of Transport.

Water Distillation Using Waste Heat

SEA water distillation has been the subject of considerable research in recent years and the necessary equipment has undergone extensive development. One line of investigation has resulted in the incorporation of the well-known "flash" principle in the range of units, developed by Buckley and Taylor, Ltd., of Oldham, of which a four-stage 50 tons per day prototype plant for distilling fresh water from sea water has successfully completed shop tests. These performance trials have been intensive and of considerable duration during which different mediums of introducing primary heat into the evaporating process have been tested, since this evaporating and distilling cycle lends itself to the utilisation of practically all forms of waste heat, such as diesel engine jacket water, exhaust gases or low-pressure exhaust steam. Our illustration is of the 50 tons per day prototype unit which receives 65,600 lb per hour of feed at 72 deg. Fah. and which is raised to 92 deg., 112 deg., 132 deg. and 152 deg. Fah. successively in four flash condensers and then to 180 deg. Fah. in a heater using 1660 lb per hour of low-pressure steam. The feed then passes through four flash vessels in which the vacuum conditions are 20·3in, 24·1in, 26·54in and 28in of mercury, the corresponding temperatures being 160 deg., 140 deg., 120 deg. and 100 deg. Fah.

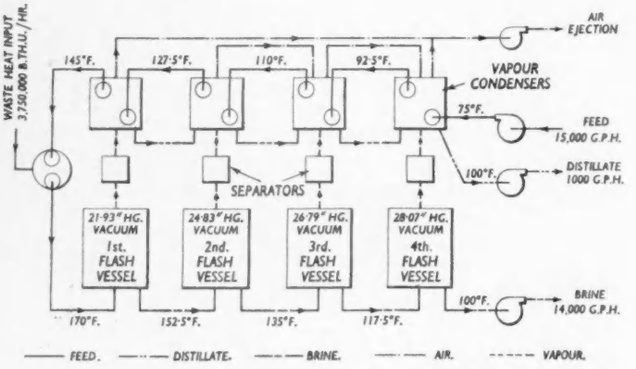


Prototype flash distillation plant of 50 tons per day capacity

Our flow line diagram illustrates a typical set of operating conditions in a 100 tons per day plant. The sea water is fed into the tube side of the lowest temperature vapour condenser where its temperature is increased by the condensing vapour generated in the associated flash chamber. Successive condensers progressively raise the temperature and then, after passing through a primary heat input exchanger, the feed is introduced into the first flash vessel where the sub-atmospheric pressure causes part of the feed to flash into steam vapour. This continues through further stages at successively lower sub-atmospheric working pressure and the partly concentrated brine is withdrawn and discharged to waste. The vapour formed passes through separators to remove entrained water droplets and is then condensed and thus provides heat for the incoming feed. The fresh water condensate cascades from one condenser to the next and is finally withdrawn and pumped to storage.

In the "Aquaflash" design scaling trouble is practically eliminated because only about one-fifteenth of the sea water feed is vaporised so that the brine concentration is low. Thus the introduction of scale inhibitors is not necessary—nor is the adoption of scale shocking routines or the incorporation of flexing elements. A contributory factor is that boiling sea water is never adjacent to a heat transfer surface, due to the change of phase from hot feed into vapour taking place in an open chamber. Months of scale-free continuous operation are possible and what scale is precipitated will occur in the primary heat exchanger. The evaporator, because of the cycle already stated, is stable and the design provides for self-regulation against operational variations.

The unit is simple to start and once the operating cycle is reached it can be left unattended for long periods. A "once-through" system has been adopted in preference to recirculation in the interests of simplicity, and the same interests together with ease of maintenance have governed the number of stages to give an optimum performance efficiency. Compared with land units, which may produce 8 lb of distillate per 1 lb of l.p. feed steam, the operating economy of the marine installations, which are restricted with regard to size and weight, is 2·6 lb of distillate per 1 lb of feed steam. Current standard units have capacities of 25, 50, 75 and 100 tons per day and the respective weights are 120, 170, 220 and 290 cwts: the last three units each have four stages and an approximate heat consumption of 373 B.Th.U. per 1 lb of distillate.



Flow diagram of 100 tons per day sea water distilling plant

Construction of Two Sea Outfall Pipelines

WORK has begun on the construction of the pipeline which will take effluent from the Atomic Energy Establishment at Winfrith Heath, Dorset, into the sea at Arish Mell. This pipeline will run for 5 miles overland from Winfrith and for about a further 2 miles out to sea. The undersea route will follow the profile of the sea bed, except in a few places where a trench will have to be prepared by blasting through reefs and rock. Small explosive charges will be used periodically and care will be taken to protect fishing interests and private property. A Notice to Mariners, explaining the warning methods which will be used, has been issued.

Work on the sea section will begin on March 27, the Atomic Energy Authority states, or soon after, and will continue until about the end of September. Constructors John Brown, Ltd., has been awarded the contract for the first 4 miles of the overland pipeline from the site boundary; Taylor Woodrow Construction, Ltd., has been awarded the contract, in association with Collins Submarine Pipelines, Ltd., for the remaining mile of overland pipeline and for the undersea section, which, it is believed, will be the longest underwater outfall to be constructed in this country.

Overseas subsidiaries of the two latter firms, namely, Taylor Woodrow (Ghana), Ltd., and Collins (Overseas), Ltd., will be working in association on another large sea outfall pipeline, for which they have just received the contract. This outfall will be over a mile long, and is to be laid in the Gulf of Guinea, off Ghana. The contract was placed by the Ghana Government's Tema Development Corporation, and its value is in the region of £500,000. Work is due to start this month and will take approximately six months to complete. The consultants are Messrs. D. Balfour and Sons.

The outfall is for the main sewer from Tema and will be 6000ft in length. It is claimed that the outfall will be one of the few such pipes so far in the world to be laid on the sea bed at a point sufficiently far from the shore to avert all danger of beach contamination, the only sewage outfall considered comparable by the Tema authorities being that recently laid from Los Angeles 7 miles into the Pacific Ocean. This, however, has a 22in internal diameter, compared with a 27in internal diameter for the Tema pipe.

The work at Tema will involve welding together short lengths of the pipe (supplied by Stewarts and Lloyds, Ltd.) into one continuous length, protecting the inner and outer surfaces and towing it out to sea. All welds will be X-rayed and particular attention will be paid also to corrosion protection. The inside of the pipe will be coated with a bitumen-sealed mortar layer applied mechanically by a specialist sub-contractor, using a machine which will travel along the pipe interior. The exterior will be coated with several layers of enamel glass fibre and bitumen, applied by special machines. Finally, the pipe will be encased with concrete, varying in thickness between 4in and 6in, which will stabilise it on the sea bed as well as affording additional protection. The overall diameter will then be just over 3ft at the smallest section and 41¼in at the other points.

The completed, fabricated pipe, of more than a ton weight per yard length, will be pulled out to sea by a winch on the anchor of a barge, so as to reduce drag on the sea bottom. Buoyancy will be given by pontoons placed at intervals along the pipe, and freed later by release mechanisms. The leading end of the pipe is to be encased in a 40-ton concrete sledge, which will also help to anchor the pipe in its final position on the sea bed in about 35ft depth of water.

SHORTER REPORTS

Atomic Research Centre for Berkeley

AT a cost of about £1,000,000 a new research centre is to be established by the Central Electricity Generating Board adjacent to the Berkeley Nuclear Power Station, Gloucestershire. It will consist of Engineering, Physics, Metallurgy and Chemistry Laboratories. The research centre will be self-contained and administratively divorced from the power station, although architecturally the buildings will be in keeping with others on the site. In siting these laboratories, the Board has had in mind the proximity to the universities in the south-west of England and South Wales. There will be openings for all types of staff, and the total number to be engaged will be about 150–200 composed of scientists, chartered technologists, and skilled and unskilled tradesmen. The Board will, therefore, look for students of applied and natural sciences from the Universities, and from local Grammar and Technical Schools. It will arrange for promising candidates to be trained in the sciences by part-time release for attendance at technical colleges and the award of full-time scholarships at appropriate universities.

One of the functions of the laboratory will be to give a constant appraisal of the state of materials used in the construction of the reactors by detailed examination of monitor samples removed on a programmed basis from the Board's operating reactors.

In the Physical Laboratories, work will be carried out on experimental programmes in nuclear and reactor physics, and considerable experimental studies will result from the programme devised for monitoring the behaviour of the graphite, which forms the reactor core, and the problems arising from a study of reactor physics during the commissioning period of reactors and thereafter.

Millbank Tower Block

ABOUT eighteen months ago, we announced that a project for an office development at Millbank, Westminster, involving a thirty-storey block, had been given planning approval by the L.C.C. Detailed planning permission has now been granted for this project and, in fact, demolition of the Victorian houses on the Millbank embankment at this site, and of the industrial buildings behind them, has already started, and it is expected that the new development will be complete in four years.

The site extends over 3½ acres, with a frontage of 650ft on Millbank, and is situated between Thames House and the Queen Alexandra Military Hospital, close to the Tate Gallery. The development is being undertaken by the Legal and General Assurance Society, and the new buildings will, in part, house the headquarters of the Vickers Group of Companies. The site forms part of an area of Thorney Island, which was bought by the Crown from the Marquess of Salisbury in 1799.

There are three main blocks in the development : a thirty-one storey tower block some 370ft high ; an eight-storey " Y "-shaped block 90ft high, and an eleven-storey residential block 120ft high. A total of approximately 350,000 square feet of office space will be provided in the two office blocks. The tower will provide a contrast to the existing pre-war development along Millbank, and the site will be kept as open as possible at ground level with gardens and courtyards providing an attractive setting for the modern lines of the buildings. The scheme has been accepted by the Crown, the Westminster City Council and the Royal Fine Art Commission, as well as by the London County Council as the overall planning authority. There will be parking space for about 250 cars at ground level and on two upper levels served by a spiral ramp.

It is proposed that the structure of all the buildings will be of reinforced concrete with cladding for the office blocks in a specially developed prefabricated curtain wall, the framing of which will be faced in stainless steel. The tower will have double windows, the outer panes being fixed and cleaned externally from power-operated cradles suspended from the roof and kept in position by guide rails built into the fabric on all elevations.

The express passenger lifts in the tower will travel at 800ft per minute. There will be a " local " group of four lifts with a speed of 700ft per minute to serve each floor in the lower half of the tower from the ground to the " interchange " floor at the fifteenth storey. The " express group " of five lifts will operate non-stop between the ground and the " interchange " floor and thereafter serve each floor from the fifteenth to the thirty-first storey.

Division of office space is to be flexible to the extent allowed by the basic module of 4ft 3in. Floor to floor heights are 10ft 9in, giving a clear floor to ceiling height of 9ft on all upper floors. An acoustic-tile suspended ceiling will conceal the piping and conduits of the services. Full air-conditioning with refrigeration in the principal buildings will be achieved with a medium high velocity system. The foundations of the buildings will rest on 500 bored cylinder piles, those supporting the tower penetrating 90ft or more into the London blue clay.

The architects are Messrs. Ronald Ward and Partners, and the consulting engineers, Messrs. R. Travers Morgan and Partners. The main contractor is John Mowlem and Co., Ltd. The total cost of the development is estimated to be in the neighbourhood of £5,000,000.

Space Flight Conferences

CHURCH HOUSE, Westminster, will this year be the venue of the first Commonwealth Spaceflight Symposium and of the tenth Congress of the International Astronautical Federation.

The former meeting, on August 27 to 28, is convened by the Commonwealth Astronautical Committee, on which are represented Great Britain, Canada, the Union of South Africa, and India. Australia and other countries are expected to be represented also. Special arrangements are being made to enable Commonwealth students to attend the symposium at a reduced fee. Persons resident outside the Commonwealth will be allowed to attend as observers. The theme of the symposium papers will be the question of Commonwealth participation in space research. Papers for presentation may be submitted to the Chairman, Commonwealth Spaceflight Committee, 12, Bessborough Gardens, London, S.W.1.

The latter meeting will take place in the week August 31 to September 5 : the last I.A.F. Congress to be held in London was in September, 1951. Registration forms are available from the Secretariat, 12, Bessborough Gardens, London, S.W.1 : papers for presentation should be submitted before June 1, 1959.

International Clean Air Conference

THE National Society for Clean Air is organising an International Clean Air Conference and Exhibition, to be held in the Seymour Hall, London, from October 20 to 23. Although the conference will emphasise the technical and administrative means for securing clean air, rather than the purely scientific and medical study of atmospheric pollution, all aspects of the problem will be included. The Society says that, so far, nearly fifty overseas delegates have been appointed, representing fifteen countries. An invitation to be represented will shortly be going out to British local authorities, organisations and firms. An open invitation to submit short written contributions for the several conference sessions has already been made to overseas bodies, and to date about thirty contributions have been offered. The invitation is now being extended to those in this country who may be able to make technical or research contributions of international interest. All accepted contributions will be printed and distributed in advance and will be discussed rather than read at the conference. Proposals for contributions should be made to the Director, the National Society for Clean Air, Palace Chambers, Bridge Street, London, S.W.1.

Progress at the Forth Bridge Site

WORK is now well in hand on the first phase of the Forth Road Bridge scheme. This contract consists of the construction of the foundations for the main piers of the bridge, including compressed air cai son work, the driving of wedge-shaped anchorage tunnels of some 200ft length, each opening out from portal dimensions of 20ft square to 40ft square at the base, and the erection of reinforced concrete towers 150ft high.

The bridge will be the largest suspension bridge in Europe and the fourth largest of its kind in the world. It will have a main span of 3300ft and two side spans of 1340ft, whilst the longest approach viaduct, that on the south side, will be some 1437ft in length. It was described in THE ENGINEER of February 15, 1957.

Access to both main piers during construction will be over temporary causeways and bridges, thus enabling easy transfer, especially during rough weather, of the superstructure steelwork. These causeways have been completed and the bridges are being erected on both sides of the river. Four dolphins have been constructed at the site of the south pier, from which diamond drilling has been carried out to investigate the bedrock before the compressed air caisson work begins. As the north main pier will be founded on the submerged whinstone outcrop known as the Mackintosh rock, no special problems are expected. The south pier, however, will require a caisson to be sunk at least 100ft into the river bed before a solid rock foundation is obtained. When completed, each pier will carry a 500ft steel tower—the main towers of the structure—constructed of prefabricated welded sections which will be assembled in position with large-diameter high-tensile steel bolts.

The cofferdams for the two side towers are also under construction and temporary timber works to support the steel frames of the south-side cofferdam are complete. Driving of piling is now under way.

The main cables will be anchored in massive prestressed concrete anchorages which will be constructed in wedge-shaped tunnels, inclined at an angle of 30 deg. on each shore. The inclined approaches to the tunnels are being excavated, and an 8ft diameter access shaft, sited 30ft behind each tunnel base, is being sunk to a depth of 100ft. On the south shore, the country rock consists mainly of a series of interbedded shales and sandstones and when the tunnel is driven, roof bolting will be necessary. The water table on the south side is being lowered by pumping out a small disused quarry next to the site. Three oil storage tanks, one of which lies across the site of the approach viaduct, are being dismantled.

This information has been received from the Consolidated Pneumatic Tool Company, Ltd., whose plant is at work on the site. This firm considers that the virtue of compressed air as a source of power is well demonstrated on this contract where a very wide range of pneumatic tools is in use. The scheme is being administered by the Forth Road Bridge Joint Board, and the consulting engineers are Messrs. Mott Hay and Anderson and Messrs. Freeman, Fox and Partners. The contractor for the first phase, valued at £2,500,000, is John Howard and Co., Ltd.

Freedom from Glare in Lighting

THE high levels of illumination now in common use in industrial and commercial premises have increased the importance of avoiding glare from the lighting fittings. Study of this problem by the research laboratories of The General Electric Company, Ltd., has led to the development of modified designs of reflectors and louvres, now embodied in a new series of G.E.C. lighting fittings known as the "Comfort Lighting" range. At a demonstration this week it was shown that even with a value of cut-off which conceals the light source at short distances, the skirt of a reflector may be quite bright, and the effect disturbing when numbers of fittings are in view. The dispersive reflector fitting illustrated is one of the designs introduced to overcome these difficulties. It is a high-mounting unit with a bare lamp cut-off of 58 deg. or 62 deg. from the downward vertical, according to the size of lamp, and an aluminium specular reflector fluted and contoured to give a low-brightness skirt. The fitting is designed to take "Osram" mercury fluorescent lamps of 250W, 400W or 1000W.

New fittings in the same range for fluorescent tubes are equipped with louvres which also have been designed to avoid the surface brightness often seen in the widely-used egg-crate form. It was explained at the demonstration that the fluorescent tube presents a particularly difficult problem, since, although in cross-section it is a compact light source, its length is such that a given part of the reflector may have to deal with light from as much as 5ft away as well as from vertically below. The fittings demonstrated generally have "Low-glo" louvres providing a cut-off in the major axis of 63 deg. from the vertical, above which a low brightness is discerned in the louvres. These take various forms and their surface may comprise numerous "steps" of different contours. In one of the fittings shown the louvres are inclined at 5 deg. to the vertical to ensure lower brightness from one direction of view than from the other, and it is therefore particularly suitable for situations

High-mounting unit for mercury-fluorescent lamp

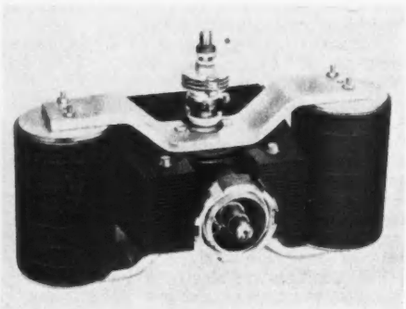
such as drawing-offices in which all occupants work facing the same direction.

The effectiveness of these methods of reducing glare may be classified according to the glare factors of Harrison and Meaker. A two-lamp fitting in the new range has a glare factor of 5 viewed endwise and 15 crosswise, and these figures may be compared with values for a bare tube in a channel fitting of 70 endwise and over 400 crosswise, but it must be realised that these figures do not represent a linear relationship.

Attention to avoidance of glare has increased the importance of finding methods for expressing this effect in a manner generally understood by all concerned with the choice of lighting equipment, and we understand that this question is being studied by the G.E.C. research laboratories at Wembley. The demonstrations emphasised how users may be misled by apparently "bright" fittings into over-estimating the efficiency of an installation, and equally how, with the new techniques, it requires a light meter demonstration to convince an observer that a glare-free fitting is providing as much, or even more, light where it is required as one of the older designs.

Magnetrons for Microwave Heating

Two new magnetrons have been introduced by Mullard, Ltd., Mullard House, Torrington Place, W.C.1, for industrial heating applications. The JN2-2·5W is an unpackaged, continuous-wave magnetron for operation in the frequency band 2425 to 2475 Mc/s. It delivers a maximum power output of 2·5kW and is designed for coupling to a 50-ohm coaxial line. The JN2–2·5W is water-cooled; an air-cooled version, JN2–2·5A, is also available. The valve is intended as a c.w. power oscillator in industrial microwave heating generators. As such its chief



Air-cooled magnetron for 2·5kW output. The valve is shown complete with its magnet system but can also be supplied independently ("unpackaged" form)

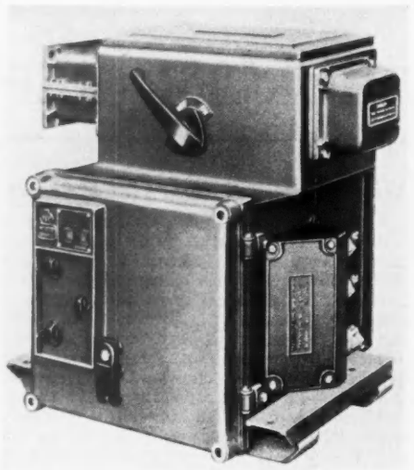
applications are expected to be in the food industries, where there is increasing interest in microwave heating for processing, de-frosting and pre-heating foodstuffs.

The second magnetron, type JP2–O2, is a packaged, continuous-wave magnetron designed expressly for low-power microwave heating applications, including diathermy. It operates within the frequency band 2425 to 2475 Mc/s, and is capable of delivering a c.w. output power of approximately 200W. The valve is designed for coupling to a 50-ohm coaxial line, and requires no artificial cooling when suitably mounted on a heat sink.

Flameproof Lighting Transformer

THE SLU lighting transformer unit illustrated here has been added to the range of flameproof equipment made to National Coal Board specification by The Belmos Company, Ltd., Bellshill, Lanarkshire. This equipment is certified flameproof by the Ministry of Power under certificate No. 4180 for group-1 gases. It can supply either three lighting circuits with a maximum capacity of 13A each or one circuit of 40A, thus supplying sufficient current for approximately forty-five 100W lamps or seventy-five 60W lamps. By means of a series/parallel link board an output of either 115V or 230V can be selected; these outputs may be varied to give 125V and 250V respectively. Earth leakage protection at all voltages is incorporated.

The housing consists of a welded steel case divided horizontally into two flameproof compartments. The upper compartment houses the 300A throughgoing busbars and two-pole isolating switch; the lower, main compartment houses the transformer and protective equipment mounted in a chassis which can be withdrawn from the enclosure on slide rails. A screwed rod through the chassis facilitates racking in. All electrical connections between the chassis and the enclosure are made by spring-loaded butt contacts and, to ensure proper connection, an interlock bar prevents the main cover



This flameproof transformer lighting panel is designed to comply with N.C.B. specification

being closed unless the chassis is fully racked in. The hinged front cover is secured by four socket-headed set screws which can be removed only by the special key provided and is mechanically interlocked with the isolating switch.

The single-phase transformer has a continuous rating of 4·5kVA and has its primary winding fitted with variable tappings on the incoming side to provide fixed output voltages from supply voltages between 400V and 650V. By means of a series/parallel link, the transformer secondary windings can be connected either in parallel to give 115V and 125V or in series to give 230V and 250V. By means of movable links the transformer can supply one 40A lighting circuit or three 13A circuits at 115V/125V; at 230V/250V the unit can supply one 20A or three 6A circuits. H.R.C. fuse-links protect each of the outgoing circuits.

A miniature circuit breaker mounted at the front of the chassis provides earth leakage protection at all voltages, tripping at all fault currents above 2A. Resetting is effected externally by a combined Test/Reset knob on the front cover.

Tribal Class Frigate H.M.S. "Ashanti"

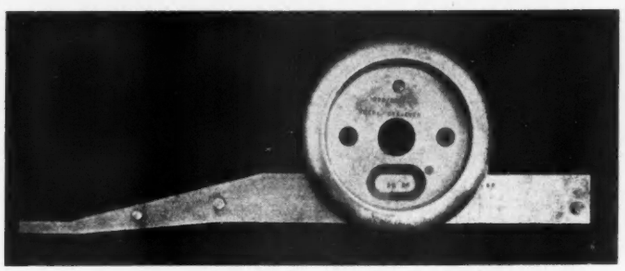
THE first ship of the new Tribal class of general purpose frigates was launched from the yard of Yarrow and Co., Ltd., on March 9 by Lady Onslow, the wife of Admiral Sir Richard Onslow. The vessel, of all-welded prefabricated construction, has a length overall of 460ft by 42ft 6in beam and the armament includes two 4·5in guns in single mountings, anti-submarine mortars and six 21in torpedo tubes, and a helicopter for reconnaissance duties. Propulsion is by a combined steam and gas turbine plant in which the steam turbine provides power for normal cruising and manœuvring while the gas turbine will boost the steam turbine to enable the ship to steam for sustained bursts of high speed. In addition the gas turbine will enable the ship to get under way at short notice without the necessity of having steam available. The design of the machinery has been evolved by the Yarrow–Admiralty Research Department, of Yarrow and Co., Ltd., in conjunction with the Admiralty and Associated Electrical Industries, Ltd. A member of the latter group, Metropolitan-Vickers Electrical Company, Ltd., is manufacturing the steam and gas turbines, both of which are geared to the same shaft, gearing and control gear. The whole machinery arrangement has been the subject of a careful mock-up to ensure an efficient layout in terms of habitability and accessibility. The machinery is remotely controlled at all powers, the controls being mounted in consoles in a special compartment. Denny-Brown stabilising equipment is fitted and the form of the ship has been designed to endow the frigate with good sea keeping qualities so that a high speed can be maintained in rough weather.

Diameter Gauge for Use With Ground Wheel Lathe

A SPECIAL gauge for measuring wheel diameters of railway rolling stock being dealt with by a ground wheel lathe on which the flanges of train wheels are machined *in situ*, has been developed by the engineers of London Transport. With this design of lathe there is no need to remove the defective wheels or even to uncouple a car on which they are fitted from the remainder of the train.

One difficulty experienced in using the lathe was that the close fit of the wheels in the bogies, together with the positions of the brake blocks, made it impracticable to use conventional gauges for measuring the diameters of the wheels to be turned.

The new gauge devised to overcome these difficulties consists of a graduated beam 11¾in long, made from gauge steel and fitted into a slot in a 4in diameter steel roller, as shown in the illustration. The beam is slidable in this slot and can be fixed by a locking screw to the roller in any position along its length. Part of the face of the roller cut away along this slot exposes the graduations on the beam, which are indexed against a fixed mark on the vertical centre line of the roller.



Wheel diameter gauge

To determine the diameter of a wheel, it is necessary only to lay the roller and beam on the running rail adjacent to the wheel. After loosening the lock screw, the beam and roller are then pushed forward until they both make contact with the wheel. The locking screw is then tightened and the diameter of the wheel can be read directly off the scale. Locating dowels appropriately positioned in the side of the beam to register against the flange of the wheel ensure that the diameter is always measured at the same distance from the flange.

Radio Link With Travelling-Wave Tubes

THE multi-channel radio and television links to be provided by Marconi's Wireless Telegraph Company, Ltd., between Oslo, Karlstad and Arvika (THE ENGINEER, February 27, page 362) will use equipment representing a new departure in S.H.F. point-to-point communication. Its salient features render it particularly suitable for long-distance trunk networks carrying telephone, telegraph or television services. Terminal equipment will be of the HM500 series, designed to provide main trunk routes with an ultimate capacity of 600 telephone channels or alternatively one-high definition television channel. Any telephony channel can be used to provide a number of voice-frequency telegraph or teleprinter channels. Performance standards are such as to enable the telephone channels to meet C.C.I.T. & T. requirements over a distance of 2500km, assuming sound route planning and suitable associated channelling equipment.

Operating in the frequency-band 3800–4200 Mc/s, the equipment provides broad modulation bandwidth and high aerial gain. Until comparatively recently broad-band amplification presented such a problem at repeaters that it was avoided by conversion of the signal to a lower frequency, where it was amplified and then reconverted to the original before translation to the " transmit " frequency. The multiple frequency conversions involved and the power-handling limitation of the mixers used constituted serious disadvantages. In the HM550 repeater apparatus an alternative is provided by the use of travelling-wave tubes, which are capable of direct amplification at U.H.F. and S.H.F. The whole system at terminal and repeater stations is designed round new high-power, low-noise travelling-wave tubes of the English Electric Valve Company, Ltd.

Engineers' order wires, both express and party line, and slow and fast system condition and control signals are normally transmitted over an auxiliary link, but where this is impossible or undesirable certain of these supervisory signals can be passed over the main link system. These circuits, which are carried in bearer channels of 300 to 3400 c/s band, may be extended from either terminal, or from a repeater station, to a telephone exchange or other control point.

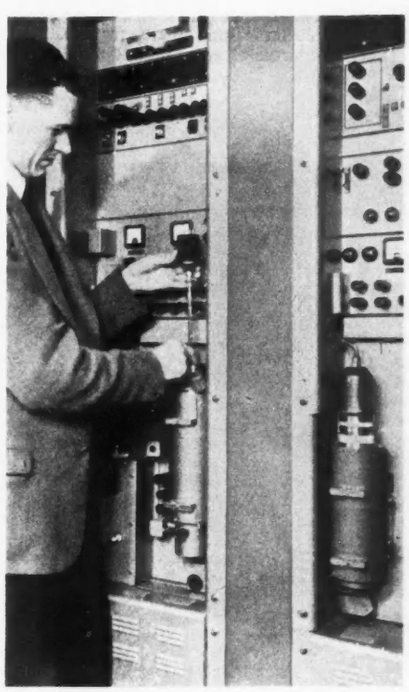
The supervisory system permits additional alarm signals to be transmitted back from a repeater to terminal stations to indicate such conditions as unauthorised entry into repeater buildings (which are normally unattended) excessive temperature, or failure of the standby diesel alternators to start. On duplicated links arrangements can be made for automatic change-over to standby equipment if any fault develops in the main link, or if there is a sustained degradation of signal/noise ratio below a predetermined level.

In the terminal equipment the traffic signal from the channelling equipment is amplified and converted to a frequency-modulated signal at an I.F. of 70 Mc/s. This I.F. is mixed with a 4000 Mc/s band signal derived by multiplication from a crystal-controlled oscillator. The modulated S.H.F. signal from the mixer drives an intermediate travelling-wave tube which in turn drives a high-power travelling-wave tube delivering 4W to the aerial feeder.

The received signal from the aerial is amplified by a low-noise travelling-wave tube having a noise factor of 10 dB, and is mixed with the output of a crystal-controlled local oscillator to give an I.F. of 70 Mc/s. After amplification the I.F. signal is demodulated and the baseband traffic signal is further amplified.

The use of travelling-wave tubes at the repeaters makes it possible to employ frequency-changing repeater stations without conversion to I.F. of the S.H.F. signal. The received signal from the aerial is amplified by a low-noise T.W.T., and then an intermediate T.W.T. It next passes to a mixer for translation to the " transmit " frequency after which it proceeds to a high-power tube having an output of 4W. Elimination of the I.F. stages results in reduction of distortion and simplification of design.

The equipment operates into spun aluminium paraboloid aerials 10ft in diameter, each having a nominal gain of 37 dB over a half wave dipole. The effective radiated power in the direction of maximum intensity is thus 20kW. The reflector is centrally illuminated by a waveguide horn. A vertex plate ensures optimum matching. The aerial is mounted in a frame which may be supported on a mast or tower.

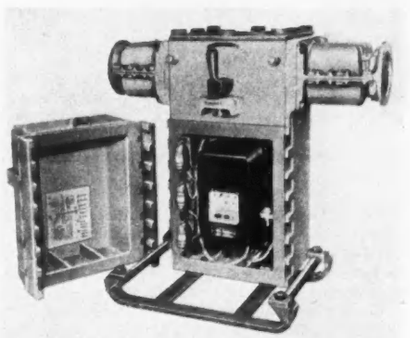


Two of the travelling-wave tubes, one of which is being inserted by the engineer, are seen in this illustration of " HM500 " terminal equipment undergoing tests

Flameproof Metering Panel

A FLAMEPROOF metering panel (BMP-9) designed to measure the unit consumption of machines or groups of machines in coal mines has been developed by Siemens-Schuckert (Great Britain), Ltd., Faraday Works, Great West Road, Brentford, Middlesex.

As illustrated here the panel consists of a flameproof tank with two separate flameproof compartments, the upper one having three busbars rated at 300A, the necessary current transformers and an isolating switch, and the lower one having a three-phase three-wire unbalanced load, two-element integrating watt-hour meter, together with fuses. The meter itself is of the standard industrial pattern.



Flameproof metering panel to measure the electricity consumption of machines or groups of machines in coal mines and other situations where flameproof equipment is mandatory

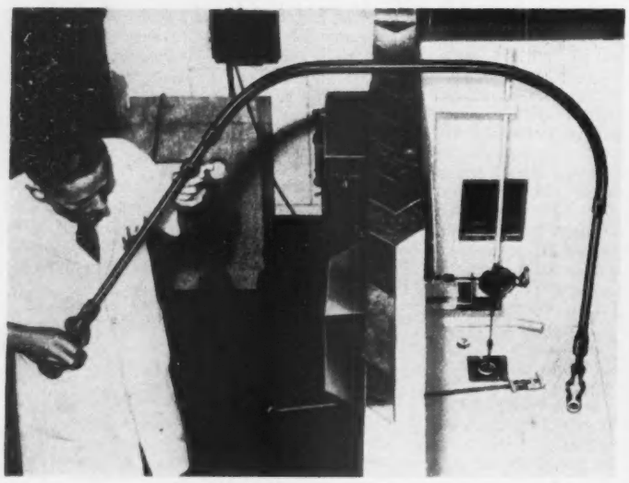
The front cover of the tank, which is interlocked with the isolator, is of the company's " single-lock " design, which dispenses with cover bolts and allows for removal or replacement of a cover simply by turning a single screw. As the unit is intended for use near the coal face and other dusty situations, no window is provided, the quick release cover ensuring that only a minute or two need be occupied in removing the cover, reading the meter and replacing the cover.

The busbar flange dimensions of the metering panel are the same as those specified in the National Coal Board specifications covering " standard " gate end panels, so that to check the consumption on a coal face, the metering panel can be lined up with the bank of " standard " panels, at the incoming side. By using " Flit " plug adaptors, as shown in the illustration, the metering panel can be inserted in the main cable run at any required point. If the consumption of a single machine is to be checked, the metering panel can be fitted with 100A plug sockets and inserted in the trailing cable run. The panel has been certified flameproof and carries the flameproof certificate No. FLP. 4046.

Tongs for Radioactive Materials

We illustrate below a new device, known as the "Overwall Tong," which has been developed by Teleflex Products, Ltd., of Basildon, Essex, to enable the handling of radioactive and toxic materials remotely and without endangering life. The device was designed in connection with A.E.R.E., Harwell. It obviates the necessity for remote handling at fixed stations and can be used for gripping, carrying and rotating whilst, being virtually free from back-lash, it is sensitive and positive in action.

The control mechanism comprises a flexible shaft, one end of which is attached to an operating mechanism, and the other to a tong head. The tong head—of standard A.E.R.E. design—is closed by a trigger mechanism, fitted with a fine adjustment for positive grip, and is rotated by a twist grip handle. A quick release trigger provides instantaneous release of the tong grip, and interchangeable tongs are available.



Tongs for the remote handling of radioactive and toxic materials

On the body there is engraved a scale of three markings, adjacent to the adjusting sleeve. This scale indicates maximum and minimum fine adjustments of the tongs by red marks, and the intermediate position by a white mark. The support handle is adjustable for position and readily adapted to suit right- or left-hand operation.

A hook is provided for storage of the device and also for the attachment of a pulley wire and counterweight if required. The weight of the unit with the tongs is 6¾ lb and without tongs 6 lb.

Control of Furnace Atmospheres

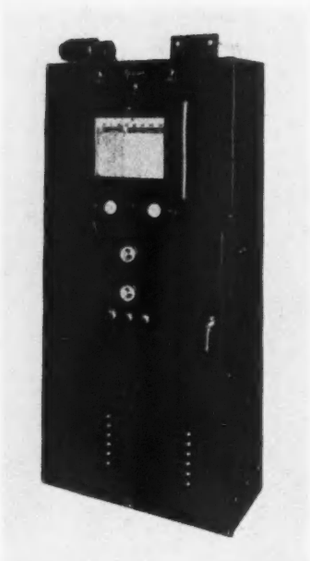
Measurement of dewpoint for estimating the "carbon potential" of furnace atmospheres has become widely accepted as a means of controlling operations such as carburising, carbo-nitriding and carbon restoration. The Ipsen "Dewtronik" instrument illustrated, now available in this country through the British Sales Office of Ipsen Industries, Inc., at 53, Victoria Road, Surbiton, Surrey, provides continuous recording combined with automatic control of the atmosphere.

Approximately 25 cubic feet per hour of the atmosphere under test is drawn through a sampling and filtering system incorporated in the instrument by a specially developed pump having carbon vanes. The sampled gas passes over the glass insulated face of a bar cooled by a refrigerating system; two platinum electrodes on the exposed glass face are connected to the "Dewtector," an electronic device which applies an a.c. potential to the electrodes and "senses" any moisture film immediately it develops. Formation of dew allows current to pass between the electrodes, and this is amplified and used to trigger a relay which switches on heaters built into the "sensing" head. Dispersion of the dew cuts out the heaters, the response of the equipment to both conditions being such that the sensing head face is maintained within 2 deg. Fah. of the true dewpoint of the sample gas.

A thermocouple with junction adjacent to the electrodes signals the prevailing dewpoint temperature to a standard indicating and recording potentiometer. Mercury switches in this instrument act according to the preset required atmosphere dewpoint to operate solenoid valves in additive gas lines or motorised ratio controllers, thereby maintaining furnace or generator atmosphere dewpoint within very close limits. Operating range is from 0 deg. to 90 deg. Fah. (or ambient temperature).

The instrument and its accuracy are unaffected by all normal atmosphere constituents, including ammonia. Correct functioning can be checked at a glance at any time, due to the rapid cycling action (approximately every five or six seconds) in normal operation. A built-in delay timer provides for automatic cessation and resumption of sampling to avoid the system being saturated by the very moist atmosphere which must prevail immediately after loading a batch furnace.

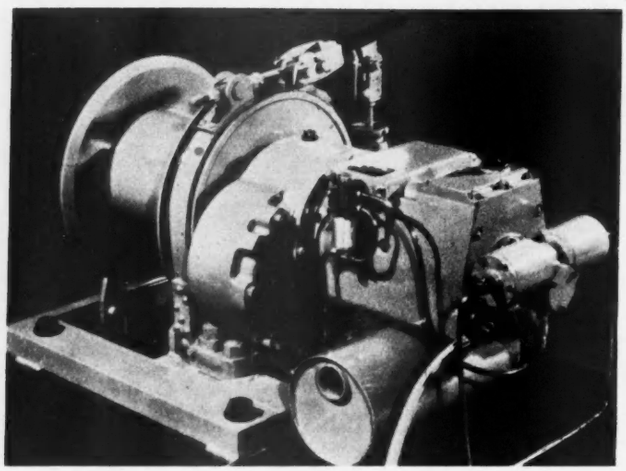
The "Dewtronik" apparatus is available as a single or multi-point recording controller. The latter form (illustrated) samples, records and controls two furnaces, two zones of one furnace, or a furnace and generator. Alternatively, either four-point or six-point equipments can be provided.



Recording controller for furnace atmospheres. The sampling pump and motor are seen on top left of cabinet, which measures 2ft wide by 1ft 1in deep by 6ft high

Remote Controls for Air Motors

A system of remote control for air motors introduced by Holman Brothers, Ltd., Camborne, Cornwall, is designed for the operation of single or multiple air motor units on such things as hoisting, winching and crane installations from a distance of up to 200ft. Prior to the introduction of this equipment forward, neutral and reverse operations had to be hand controlled at the air motor itself. An air motor fitted with the new control can be seen in the accompanying illustration.



Air motor and hoist fitted with remote control equipment which operates the neutral, forward and reverse movements of the hoist drum

The remote control equipment for each of the "Rotomotor" units made by the firm comprises a hand-operated lever valve situated on a control panel and, in the motor, a rack, actuated by duplex pistons situated at each end, which engages a pinion on the reversing valve. With the control in the neutral position compressed air is applied to both ends of the duplex pistons, and the reversing valve shuts off the air supply to the motor. When the forward or reverse position is selected through the lever pressure is released from one side of the duplex piston which moves the rack across to turn the reversing valve, to admit air to the required side of the motor rotor vanes. An emergency stop valve, which can be placed in circuit in front of the control valve, automatically returns it to the disengaged position irrespective of the position of the control valve.

The reversing control valve used can be either of the single lever operated or of the two push-button design which automatically assumes neutral upon release. A lever control valve can be fitted which also reverts to neutral upon release. Provision is made on the motor for a valve to control the supply of air to a spring-operated air release brake cylinder when required. Where very fine control or inching is necessary, a "Maxam" slow lowering control valve can be supplied. This valve works directly on the brake cylinder and permits the operator to position a load accurately.

The new control valves are made in two sizes, one of $\frac{5}{16}$in for pipelengths up to 40ft from control to motor, and the second of ½in for greater distances.

The "Rotomotor" motors can be ganged in pairs on to a common gearbox and remotely controlled as one unit, and they can also be arranged for left and right movement on air-motor driven travelling mountings.

Copy Milling Machine

A NEW series of " Tracemaster " copy milling machines being made by Hayes Engineers (Leeds), Ltd., Gelderd Road, Leeds, includes the " T.M. 43D " model profile milling machine illustrated on this page. It is particularly intended for 360 deg. copy profile milling, and has a 43in by 11in table with a longitudinal traverse of 14in and a cross traverse of 9in, the speed of traverse being steplessly variable up to 20in per minute. The table height is adjustable by hand over a distance of 12in and the spindle has a vertical adjustment of 3½in.

The table longitudinal and cross slides are both actuated by hydraulic rams controlled by a " Digitrace " 360 deg. hand-controlled tracer valve, which is equally suitable both for internal and external profiles. This valve consists of two tracer valves operated by a common stylus. The stylus always remains vertical, but is free to move in any horizontal direction, the amount of movement being adjustable by means of a graduated ring at the base of the valve. The amount of free movement of the stylus determines the speed of traverse and it is stated that where accuracy is important an adequate traverse speed can be obtained with a deflection of 0·001in. The stylus is self-centring so that both slides are stationary when the stylus is in its central position. During machining the stylus is held in contact with the template by the operator and deflected in the direction of traverse required. By this means the stylus is traversed round the template and as the operator always fully deflects the stylus, the speed of traverse is kept constant. This method of profile milling allows a high degree of accuracy and is useful when machining components of a complicated nature as the operator can select at will the path to be taken.

Two hydraulic rams which are used for balancing the weight of the knee assembly on the machine make vertical hand traverse very easy. The tracer valve is mounted in a bracket having a 6in longitudinal and a 6in vertical adjustment, and a lateral adjustment of ½in further simplifies setting up. The milling head is of rigid construction having a positive fine feed to the quill and means of rapid traverse by a hand lever.

The standard milling head is driven by a nine-speed gearbox giving spindle speeds from 50 to 2400 r.p.m., whilst self-contained high-speed milling heads are available having ranges of 1000 to 6000 r.p.m. and 6000 to 12,000 r.p.m. A hydraulic pump unit bolted to the left-hand side of the machine base, incorporates two independent hydraulic circuits, one for operating the longitudinal slide and one for the cross slide.

Medium-Capacity Plant for Coated Macadam

THE modern coated macadam plant—a plant centrally situated in the area which it serves and largely automatic in operation—has a history of some ten years. The progress made in design during that time has been described as " one of the most important revolutions in the history of road surfacing in this country." Two such plants were described in this journal last year, one at Teesport, which is part of a larger installation for preparing slag aggregate was described comprehensively in our issue of April 18, 1958, and the second, at Hayes in Middlesex, was briefly described in our issue of June 13, 1958, soon after it had been opened. Both of these plants were of large capacity, having two 60 cubic foot paddle mixers, and giving an output of coated products of about 150 tons per hour.

A new plant recently opened by Crow, Catchpole and Co., Ltd., at the new wharf at Cliff Quay, Ipswich, is of interest as an example of a smaller installation, demonstrating that the same principles of automatic control can be " scaled down " to suit a plant serving a smaller market. This plant is based on one 36 cubic foot mixer, with the other elements of the plant scaled down accordingly. Slag aggregate is delivered by ship from the Teesport plant and four different binders are handled. The aggregate is fed from quayside storage dumps to a rotary drier, a screen house with storage bins, and thence to the mixer house. The capacity of the plant is around 30/35 tons per hour, a production of about 300 tons per day being achieved. The general principles of control and operation follow those described in our article of April 18 last, but are more simple, especially in the electrical system. Apart from the " traditional " coated materials, viz. tarmacadam, tar-paving bitumen macadam and cold asphalt, the plant is also capable of producing the more recently developed coated materials, mainly dense bitumen macadam, straight-run bitumen macadam, dense tar surfacing and high-viscosity tarmacadam. The plant is normally operated by three men.

Continuous Rotary Milling Machines

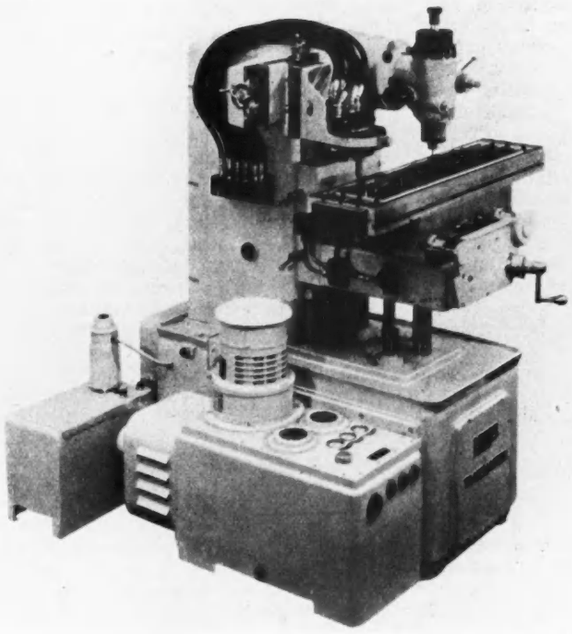
Two high-speed, continuous, rotary milling machines have been designed and built by Wadkin, Ltd., Leicester, for Hoover, Ltd., for the machining of aluminium alloy die castings used in vacuum cleaners. On these machines, one of which is shown with the guards removed in the accompanying illustration, four components are machined at each revolution of the table and the designed output is 500 units an hour.

Each machine comprises a substantial cast iron base which carries a 48in diameter rotary table and has an extension on which there is mounted a high-speed vertical milling head. The spindle in this head is driven through two-step pulleys and a two-speed motor giving four speeds of 6000, 4000, 3000 and 2000 r.p.m. The head is mounted on slides on which its height is adjustable through 12in by means of hand-wheels, its weight being counterbalanced and hand-operated locks being provided. Along the base member the head column has a horizontal adjustment of 12in for setting purposes. For this class of work the spindle is fitted with a 6in diameter face milling cutter with six inserted tungsten carbide-tipped cutters. At 4000 r.p.m. this gives a peripheral cutter speed of about 6300ft per minute, the table feed used being 100in per minute. Three table speeds are available through a gearbox to give 1, 0·66 and 0·33 r.p.m., corresponding to peripheral feeds of 150in, 100in and 50in per minute respectively.

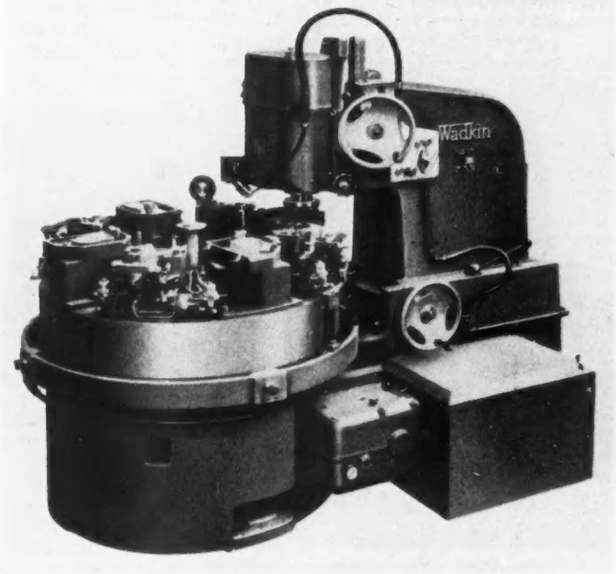
All of the work fixtures on the table are air-operated, the air clamps being actuated by a cam bar to lock a component just before it passes under the cutter head. Immediately after passing the cutter the clamps automatically release the components held in the fixtures. In this way all that an operator has to do is to drop components into the fixtures and lift them out on completion of machining.

Two safety measures are provided ; first, each component is pressed down into the fixture by a rubber roller to ensure correct seating before clamping takes place ; secondly, a trip flap is fitted immediately before the machining station and is actuated by any insecurely seated component to stop the machine before it reaches the cutter.

A special swarf extraction unit developed to remove the large volume of material removed by these high-speed machines conveys the chips straight to storage bins.



Machine for 360 deg. copy profile milling with hydraulically-operated longitudinal and transverse table movements under stylus control



Continuous rotary milling machine with guards removed to show arrangement of fixtures round the table

Industrial and Labour Notes

Industrial Costs

Addressing the annual meeting of the British Employers' Confederation, which was held in Glasgow on March 5, the president, Sir William Garrett, emphasised the necessity of keeping industrial costs steady. That, he said, was essential if the country was to maintain its competitive position in the world's markets and the purchasing power of its currency at home and abroad. Labour costs, Sir William commented, had continued to rise in the past year, albeit at a slower rate than in recent years ; with the hoped-for increase in the level of industrial activity over the coming months, it should be industry's task not only to halt the trend towards rising internal costs, but, if possible, to reverse it. The need to do so was evident from the fact that, with reviving world activity, prices of raw materials imported from overseas already showed a tendency to rise in terms of the prices obtained for the goods manufactured from them.

Sir William went on to say that the fall in industrial activity in 1958 had been reflected in a somewhat higher level of unemployment than that to which this country had become accustomed in post-war years. The situation of several jobs chasing every individual man was not a healthy one and itself contributed very largely to the inflationary pressures which steadily depressed the value of the pound sterling. No responsible person to-day, Sir William observed, entertained the idea that employment should be artificially maintained at some predetermined level. No one, however, should minimise the individual hardship which unemployment caused to those who found themselves for any prolonged period of time out of a job. Unemployment represented a failure to use to the maximum the skill and ability of the country's human resources though it would be idle to pretend that a precise balance between men and productive jobs could easily be maintained. Nevertheless, Sir William added, that should be the aim.

Employment and Unemployment

According to the Ministry of Labour's latest report, the number of people in civil employment in Great Britain at the end of January was 22,820,000 (15,139,000 men and 7,681,000 women), which was 51,000 fewer than a month earlier. The biggest reductions occurred in agriculture, building and contracting and in the distributive trades.

In the manufacturing industries there was an overall decline, during January, of 3000 in the number employed, making the total at the end of the month 9,063,000. In the engineering, metal goods and precision instruments group the labour force declined by a further 3000 during January, making the total 2,789,000, compared with 2,857,000 a year earlier. On the other hand, employment in the vehicle building group increased by 4000 during January, bringing the total to 1,226,000. The Ministry of Labour estimates that, in the week ended January 24, the number of operatives working short time in the manufacturing industries was 168,000, which was 4000 less than at the beginning of that month. In the four-week period ended February 4, the employment exchanges filled 145,000 vacancies ; the number of vacancies notified but still unfilled on February 4 was 154,000.

The latest available figures about unemployment relate to February 9, on which day there were 608,663 people registered as out of work in Great Britain. That figure, which was 12,123 below the January 12 total, represented about 2·8 per cent of the total number of employees. It included 549,137 who were wholly unemployed and 59,526 who were temporarily stopped. The Ministry of Labour says that, of the wholly unemployed, 301,771 had been out of work for more than eight weeks. The number of people registered as unemployed in Northern Ireland on February 9 was 44,100 (9·4 per cent of the total number of employees) which was 1600 less than on January 12.

Multi-Storey Factories

The great majority of new factory buildings are, these days, single-storey structures. Demand for flexibility and simple layouts for handling and production, have encouraged the use of the single-storey building. Although some manufacturing processes must necessarily be carried on at a single level, there are many others which may be suitably done in a multi-storey factory, and there is some reason to believe that the advantages of the multi-storey layout may have been rather overlooked in the recent past. The Building Research Station has drawn attention to this problem, with the publication of the first of a series of research papers, which is entitled *Modern Multi-Storey Factories : A Discussion of Their Design.**

The Station's research was prompted by the Midland Regional Board for Industry, which considered that there was a real need for information on this subject. The report is thus a general survey, intended primarily for factory managements and architects or building designers, rather than for specialists ; there will be other reports in the near future, however, for specialised aspects of this problem. The interest of the Midland Board in multi-storey factories arose from considerations of (*a*) the modern tendency for expansion in floor space per worker, (*b*) physical restriction on factory sites in the West Midlands, and (*c*) the tendency, when rebuilding, to change from multi- to single-storey premises, with consequently greater site area. The report lays particular stress on the need for planning multi-storey factories carefully, and points out that successful development of this kind depends on clarity in assessing future needs and in avoiding designs which render changes in production difficult to accommodate ; the multi-storey factory may, nevertheless, have advantages to offer.

Lloyd's Annual Report

Lloyd's Register of Shipping has issued its annual report for the year 1958, to which the chairman, Mr. K. R. Pelly, contributes a foreword reviewing the events of the past year, and mentioning the visits of representatives of the Polish shipbuilders and a delegation from the U.S.S.R. In the section on "Ship Construction and Classification," reference is made to some of the ships built to the Society's classification ; it is stated that, although there was some falling off, the plans approved for new tonnage covered more than 5,000,000 tons, of which about 59 per cent represented tankers.

The report goes on to comment on changes in the rules, classification, load lines and yachts. Higher steam temperatures up to 1050 deg. Fah. are referred to, as are diesel engines developing 20,000 to 25,000 b.h.p., and a free-piston gasifier of 2000 h.p., which is being developed by the Fiat Company. After noting some interesting machinery installations, the report goes on to refer briefly to the present position of nuclear propulsion, electrical installations and refrigeration plant before turning to the work of the land division and the Society's requirements for metals and plastics. A selection of surveyors' reports from many countries and dealing with ships, dry docks, steel mills, oil refineries, &c., is included in the report. Following particulars of the membership of the various committees there are the statistical tables, which show the tonnage of new ships classed annually by Lloyd's Register, the flag and age distribution of the world fleets, the propulsion and fuel analysis of world tonnage, and the tonnage and age distribution of oil tankers.

* H.M. Stationery Office. Price 2s. 6d.

Refrigerator Factory for South Wales

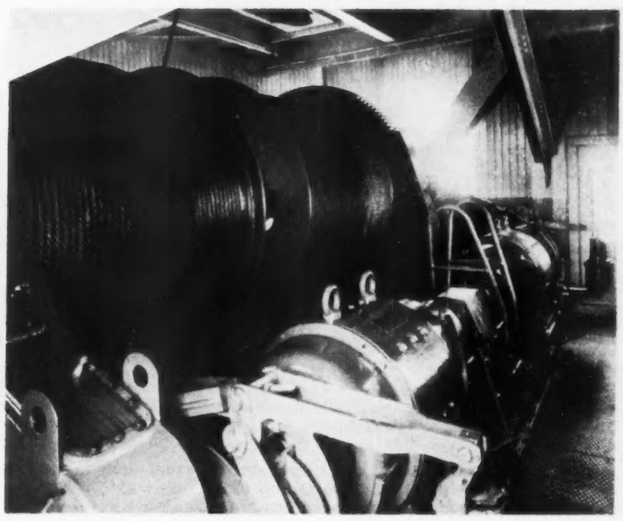
Last week, the cornerstone was laid of a new factory which is being built by the Board of Trade at Crymlyn Burrows, near Swansea, for the Pressed Steel Company, Ltd. When this factory, which will cover an area of 520,000 square feet, is completed it will undertake the manufacture of the whole of the company's refrigeration equipment, which is at present made in works at Cowley and Theale, near Reading. The company says it will not only enable a marked increase in refrigerator production, but will release urgently required capacity at the two other works for motor-car body manufacture. Plant and fittings to the value of £2,750,000 are to be installed in the new factory, and it is expected that the production of certain refrigerator equipment will begin in May, 1960, when employment will be provided for about 4000 people. When the plant is in full production, probably by the end of 1961, it is expected that between 8000 and 10,000 refrigerators will be made each week.

Iron and Steel Scrap

Estimates made by the British Iron and Steel Federation show that between September last and the beginning of this month between 400,000 and 500,000 tons of iron and steel scrap, mainly the heavy grades, have been exported from this country. There is evidence, the Federation says, that home scrap is now arising less freely, particularly in the better qualities. It is felt, therefore, that if arrangements can be made by the steel industry to stock shipbreaking scrap and if steel makers will maintain their stocks at least at their present level, a major portion of any surplus scrap may be absorbed and a complicated scheme for the stocking of scrap avoided. With this end in view, steel makers will not reduce their scrap stocks further and the British Iron and Steel Federation has put in hand arrangements whereby shipbreaking scrap will be stock-piled at an annual rate of 250,000 tons. The steel industry is thus able to assure the scrap merchants that scrap stocks will not fall below the level held at January 24 ; as far as possible purchases by the steel makers will be commensurate with the rate of consumption.

200-ton Floating Cranes

A FEW months ago, a heavy floating crane of 200 tonnes capacity at 8m radius was taken into service in the Port of Hamburg. The crane was built in co-operation by the firms Demag Aktiengesellschaft, Duisburg, which supplied the crane itself, and Blohm and Voss, Hamburg, which built the pontoon. The equipment, which is shown in the accompanying illustration, Fig. 1, is capable of a main lifting effort of 50 tonnes at 28m radius measured from the edge of the bow fender. Corresponding maximum loads at smaller radii are 60 tonnes at 25m, 80 tonnes at 20m, 110 tonnes at 15m and 150 tonnes at 10m. When working over the beam, the crane can handle up to 200 tonnes at 6m radius. In all positions, the auxiliary hook can lift 10 tonnes. The lift amounts to 46m, 28m are above the surface and 18m below.



Figs. 1 and 2—(Left) Floating crane at work moving the superstructure of a 2-ton portal crane. (Right) Two 100-ton electric winches are used for the two main hooks, which can be used separately or in combination

Structurally the crane consists of plane and space lattices of welded members which are connected by riveted joints. Level luffing is achieved by the use of twin four-bar linkage booms.

The main winch mechanism comprises two separate 100-tonne units, Fig. 2. For loads in excess of 100 tonnes, the two hooks are connected by a steel joist carrying a 200-tonne hook. Lesser loads can be handled by one of the winches operating by itself.

The luffing spindle and its operating mechanism are mounted in the superstructure and can tilt about a horizontal axis as required. A three-stage reduction gearbox turns the nut on the stationary spindle. The horizontal movement at the hook is 4·4m per minute, or five minutes for the full movement.

Hoisting speeds are 6·3m per minute for loads of 0 to 37·5 tonnes, 6·3m or 4m per minute for 37·5 to 75 tonnes, and 4m per minute in the range 75 to 200 tonnes. For the auxiliary hoist, 25m per minute is provided for loads up to 5 tonnes and 16m per minute for larger loads up to 10 tonnes.

Turning speed is 0·2 r.p.m. Up to 150-tonne loads can be moved in two ways simultaneously, i.e. they can be raised and luffed, or raised and turned, but luffing and turning cannot be combined, neither can the main and auxiliary hoists be used at one and the same time.

Counterweights are provided in the form of a fixed counterweight of 250 tonnes on the crane behind the engine cabin, and a movable 30-tonne weight, connected with the boom by a symmetrical linkage. In addition, there are 370 tonnes of ballast in the stern of the pontoon. The latter has a length, without fenders, of 42m, and a beam of 22m. The sides are 5m high and it has an average draught of 2·9m.

The main machinery is located in the centre of the pontoon and comprises two similar 515 h.p. diesel engines, each coupled at one end to a 160kW, 400V d.c. Ward-Leonard generator for the main and auxiliary winches, and by way of propeller shafting to a Voith-Schneider propeller. At the other end, the diesels each drive a second 62kW, 400V d.c. Ward-Leonard set for turning and luffing, an 85kVA, 380/220V, three-phase generator for the mains supply, and a 12·5kW exciter. The diesel plant drives the crane or the propellers as alternative.

For providing electricity during periods of standstill of the main machinery, the crane is equipped with an auxiliary 21kW, three-phase generator driven by an air-cooled diesel engine.

The Voith-Schneider propellers are mounted fore and aft and have, respectively, a capacity of 490 h.p. and 450 h.p. They can give the unloaded crane a speed of about 6 knots against a wind of Beaufort scale 2. Accommodation for the crew is provided below deck in the pontoon.

Raw Materials Survey in Thailand

During the period November, 1957, to October, 1958, a survey of iron ore, coal and mineral deposits was carried out at the instance of the Thailand Government by a German team. In its preliminary report, the expedition states that it has carried out the required investigation of nine iron ore deposits, one deposit of coal, and two sites where minerals used in iron smelting had been found. In addition, seven further iron ore sites were investigated or located.

The principal ore deposits are at Uem Kruem (140km in a direct line west of Bangkok), Hin Dad Thong (150km west of Bangkok), Chieng Kan (460km north of Bangkok) and Plang Yao (85km east of Bangkok, near the Gulf of Thailand). As regards the quality of the ores, these consist partly of high-grade magnetites, partly of brown and red hæmatites of very variable iron and manganese content. Although a final verdict, in particular as regards the poorer ores, must await a full evaluation of the samples taken, it can already be said that at least a large proportion of the Thailand iron ores can be economically smelted without treatment.

Deposits of laterites were found to be far more widespread than had previously been assumed. These products of weathering of the tropical zones occasionally exhibit crusts near the surface which contain 20 to 50 per cent of iron. Many of these sites occur in the vicinity of railway lines and preliminary trial treatment has shown promising results, so that further investigations are planned.

The only deposit of coal is at Mao Moh, near the town of Lampang in the north, 490km from Bangkok. Tests have shown that the coal can be turned into low-temperature coke suitable for the Renn process. It has not been possible so far to produce blast-furnace coke. Although the experiments are continuing, it remains to be decided whether it would be economically justified to build blast-furnaces, in view of the comparatively low inland demand for iron and steel.

Fluxing minerals are found sufficiently close to the iron ore deposits and can be obtained without difficulty. For the erection of an iron and steel plant, the only site which is considered possible is in the neighbourhood of Bangkok, near the ore deposits of Uem Kruem, Hin Dad Thong and Plang Yao, as well as the most important deposits of laterite. This would mean, however, that coal would have to be brought by rail over 600km. The main report on the survey will probably be submitted in April.

Fall in European Coal Output in 1958

PROVISIONAL figures compiled by the Secretariat of the United Nations Economic Commission for Europe (E.C.E.) indicate that the total European output of hard coal (excluding that of the U.S.S.R.) reached 616 million metric tons. This was a reduction of 6,000,000 tons, or 1 per cent, over the 1957 level.

The 1958 end-year figures are supplementary to figures published in the last edition* of the E.C.E. *Quarterly Bulletin of Coal Statistics for Europe* issued in February, 1959, which covered the first nine months of the year.

At the same time, stocks of unsold coal at pithead continued rising throughout the year. In Western Europe they rose from 16,000,000 tons at the beginning of the year to 45,000,000 tons by the end of December. Levels of pithead stocks at the end of December, 1958, were : Belgium, 6,900,000 tons ; France, 7,600,000 tons ; Netherlands, 800,000 tons ; Western Germany, 8,600,000 tons ; the Saar, 900,000 tons, and the United Kingdom, 20,000,000 tons. In Poland and the U.S.S.R. pithead stocks were at normal levels : 650,000 tons in Poland and 7,500,000 tons in the U.S.S.R.

E.C.E. provisional figures indicate that the main reductions in output occurred in Belgium (down 2,100,000 tons) and in the United Kingdom (down 7,800,000 tons). Although short-term working because of market conditions took place both in Belgium and Western Germany, the reduction in output in the latter country was small, mainly because of improvements in productivity. In the United Kingdom a number of measures were taken to bring production more into line with demand. Increased output took place in Czechoslovakia (up 1,400,000 tons), Poland (up 1,000,000 tons) and France (up 900,000 tons).

In the U.S.S.R. output of hard coal and lignite together increased by 33,000,000 tons, i.e. 7 per cent, to reach nearly 500 million tons. In the accompanying table, European coal output in recent years is reviewed.

Foreign Trade in Coal.—Provisional figures show that imports of hard coal by Western European countries (imports from within and without Western Europe) totalled 69,000,000 tons in 1958 compared with 89,000,000 tons in 1957. Imports from all sources other than Poland and the U.S.S.R. declined as compared with 1957. Imports from the United States, included in these totals, amounted to 31,000,000 tons as compared with 45,000,000 tons in 1957.

Imports from Belgium, totalling 3,000,000 tons, declined by 1,600,000 tons over the previous year, imports from France at 1,300,000 tons were reduced by 500,000 tons, while those from Western Germany at 11,500,000 tons declined by 1,800,000 tons and those from the United Kingdom at 3,900,000 tons were reduced by 2,900,000 tons.

Imports from Poland which amounted to 7,000,000 tons showed an increase of 1,100,000 tons while those from the U.S.S.R. at 3,100,000 tons showed an increase of 1,400,000 tons (excluding exports to Yugoslavia).

Western Germany was the largest hard coal importer in 1958 (16,000,000 tons compared with 21,000,000 tons in 1957). France followed with 15,000,000 tons, being a decrease of 3,000,000 tons over the previous year. Italy took third place with 9,000,000 tons compared with 12,000,000 tons the previous year. Other large hard coal importers were : the Netherlands, 7,300,000 tons compared with 8,700,000 tons the previous year ; Belgium, 5,300,000 tons compared with 5,100,000 tons in 1957 ; Austria, 3,800,000 tons compared with 4,600,000 tons last year. The United Kingdom imports declined from 2,900,000 tons in 1957 to 700,000 tons.

Principal importers of United States coal in 1958 were the Federal Republic of Germany (11,600,000 tons, 15,600,000 tons in 1957), Italy (6,500,000 tons, 8,200,000 tons in 1957), Netherlands (3,500,000 tons, 4,500,000 tons in 1957), France (2,800,000 tons, 6,900,000 tons in 1957), Belgium (1,800,000 tons, 2,100,000 tons in 1957) and Austria (1,400,000 tons, 2,000,000 tons in 1957).

Part of the reason for the rise in coal stocks is connected with the decline in iron and steel production. In the United Kingdom, by the end of the year the industry was working at only 75 per cent of capacity. Total production for the year had reached 19,600,000 tons or 2,000,000 tons less than in 1957. In the European Coal and Steel Community, there was a 3 per cent drop in steel production, from 59,800,000 tons to 58,000,000 tons. This volume represented 87 per cent of blast-furnace and 80 per cent of rolling mill capacity. Steel consumption, however, had not decreased but stocks had been falling.

TABLE I—*European Hard Coal Production*

(in million of metric tons)

Country	1937	1955	1956	1957	1958	Percentage change—1958 compared with 1957
Belgium	29·9	30·0	29·6	29·2	27·1	−7·2
Czechoslovakia	16·8	22·1	23·4	24·2	25·6	+5·8
France	44·3	55·3	55·1	56·8	57·7	+1·6
Saar	13·4	17·3	17·1	16·5	16·4	−0·6
Western Germany	137·6	130·7	134·4	133·2	132·6	−0·4
Netherlands	14·3	11·9	12·0	11·7	12·2	+4·3
Poland	66·0*	94·5	95·6	94·1	95·1	+1·1
United Kingdom	244·3	225·2	225·6	227·0	219·2	−3·4
Other European countries (except U.S.S.R.)	12·9	27·9	28·6	29·9	30·4‡	+1·7
Total Europe (except U.S.S.R.)	579·5	614·9	621·4	622·6	616·3	−1·0
U.S.S.R.†	128·0	391·0	429·2	463·0	496·0	+7·1

* Post-war territory. † Including lignite. ‡ Provisional.

* *Quarterly Bulletin of Coal Statistics for Europe*, Vol. II, No. 3 ; 90 pages. Bilingual English/French edition available from Sales Agents for United Nations Publication, and from Sales Section, European Office of the United Nations, Geneva. Price $1.00, 7s. sterling, Swiss francs 4, or equivalent in local currencies.

Conseil National Du Patromat Français

The Conseil National du Patromat Français (Federation of French Industries) held its annual general meeting on February 18. The president, Monsieur George Villiers, referring to the unrivalled expansion of French industry, stated that production had increased by 105 per cent since 1938, and 52 per cent since 1952. Such figures gave only a partial impression of the transformation which had actually taken place. There had also been unprecedented difficulties, such as the foreign exchange crisis at the beginning of 1958, which had threatened to cut off essential imports, causing stagnation and unemployment. The measures which the C.N.P.F. had proposed at an extraordinary general meeting on May 13, 1958, comprised the reduction of public expenditure, restoration of true prices and a true currency, and the development of investments through savings made possible by a renewal of confidence. At the end of the year, measures for safeguarding the community had become inevitable. Although hurriedly introduced, because of the emergency, and inadequately explained to the public, they had fulfilled their purpose, and confidence was returning, both within and outside the country.

In order to prepare the basis of a new expansion, it would be necessary to devote as a matter of priority a proportion of the national output to the purchase of essential imports and the making of essential investments.

During the last thirteen years, France had spent 5900 milliard francs (1959 value) on imports. The sources of these amounts were now exhausted. It had become essential to export in order to pay for imports. While rejecting proposals for a Free Trade Area as contrary to the unity of Europe and of the French Commonwealth, French industry recognised that the road of progress lay along a gradual abolition of protective duties. The coming into existence of the Common Market had to be faced, and industry would meet the challenge. But all possible help must be given through the professional organisations, and through combination in manufacture and in selling where individual resources were inadequate. The State, on its part, would have to adapt its methods to a modern—that is, export-orientated—economy. The time for sterile controls was past. The administration must be streamlined and decentralised. Collaboration with industry in developing markets was necessary. In order to meet international competition on equal terms, a strong and freely convertible currency was essential, something which French industry had been lacking for decades. It was essential to reform a financial policy which penalised the most productive enterprises.

Although wartime destruction had been made good, the task for investment remained enormous ; there were many more young people to school, house, employ ; there was the task of building up Algeria, and the preparation for the Common Market by adopting and re-equipping industry. The limit of what was possible had now been reached with an investment budget of 1400 milliard francs, although this sum was considerably less than was needed.

While the Government had been working in the right direction when it put the fight against inflation foremost on its programme, the most fundamental task, nevertheless, was to restore the position of savings as the decisive and irreplaceable source of investment. But how could people be induced to invest if the State, by reiterative taxation, appropriated 80 per cent or more of the resulting profits ? Another disincentive to investment, especially in the case of family businesses, was the crushing death duties.

If the public finances were to be put on a sound footing, it would be necessary to reduce private consumption. The sacrifices involved would be short-term only, if savings were thereby encouraged and if the State reduced its own expenditure. This now amounted to nearly one-third of the national income. Public credits of the central authority had increased by 81 per cent between 1952 and 1959, 17 per cent alone since 1958 ; price increases accounted for only 22 per cent of this figure ; the total of military expenditure had increased by 24 per cent, while civil capital expenditure had increased by 46 per cent and current expenditure by 129 per cent. An overhaul of the administrative structure, and of the control of the State over industry, was now imperative.

It was the task of the leaders of industry to combat to the utmost any further price increases, to export, and to invest, and so avert crisis and unemployment. Collaboration with the free trade unions had yielded a new agreement for unemployment relief, with benefits of 40 per cent of income for the higher wage groups to over 85 per cent for the lowest.

Collaboration between employers' organisations and free trade unions would help to smooth the social changes involved in the industrial reorganisation, which had as its ultimate object the maintenance of the highest possible degree of employment. One of the major obstacles to this reorganisation was the housing shortage, the result of forty years of neglect, and a problem which was nowadays peculiar to France and unknown in other industrial countries.

France had made her choice between decline in isolation and progress in contact with the most advanced industrial nations. The task of reform was only in its beginnings, and it was up to the whole of the country to carry through the necessary changes, thereby serving progress of the nation and a civilisation founded upon liberty.

Progress of the Tennessee Valley Authority

BY OUR AMERICAN EDITOR

No. II—(*Continued from page* 401, *March* 6)

Water Control Operations

SO that it may perform its functions of flood control, navigation improvement, power production and other desirable purposes, the pattern of operation of the multiple-purpose system is geared to the Valley's pronounced seasonal variation in rainfall and run-off. The region is characterised by a winter season of area-wide storms and high run-off during which the major flood conditions generally occur. Spring and summer seasons bring ample rainfall but lesser run-off and therefore a diminished flood danger. In this period, the reservoirs may safely be filled. In the autumn season both rainfall and run-off are lowest. Following this pattern, the flood control system is operated to provide large storage space for regulation during the flood season. This stage is followed by a period when the reservoirs are filled to achieve maximum head for power production. Then follows a gradual drawdown until the reservoirs reach their low flood control levels again at the beginning of the flood season about January 1. At the beginning of the fiscal year, July 1, 1957, the reservoirs had 7,760,000 acre-feet of water as useful storage. During the next months, considerable water was drawn from the reservoirs because of low rainfall and run-off. In October rainfall and run-off picked up, delaying the draw-down in most tributary storage reservoirs. In mid-November heavy rains resulted in flood-stage flows. Storage increased in most of the tributory reservoirs. Thereafter water was drawn rapidly from the reservoirs to bring them to planned flood control levels by January 1. This operation required releases through sluiceways, in addition to turbine use, at three of the multiple-purpose reservoirs on the tributaries.

In January, February and March, rainfall was below normal. However, heavier than normal rain in April and May brought substantial gains in the storage in all reservoirs. In May, the South Holston reservoir was filled to its maximum level of record, Norris and Cherokee to their second highest, and Douglas to its third highest. At Norris, the drum gates were raised and water stored above the spillway crest for the first time since the spring of 1944. On May 14, a maximum useful storage of 10,930,000 acre-feet was reached in the reservoir system. During the remainder of the fiscal year, tributary reservoirs were drawn upon to supply water as needed for power generation. At the end of the year, useful water in storage totalled 8,040,000 acre-feet, or about 4 per cent more than at the beginning of the fiscal year, and 85 per cent was in the reservoirs upstream from Chattanooga. Besides operations for flood control, navigation and power, a number of special operations were undertaken when they could be accomplished without detriment to the primary purposes. For example, water levels were maintained as stable as possible in the tributary reservoirs during the fish spawning season. Turbine releases were stabilised at three dams for thirty-hour periods to facilitate a study of re-aeration of water by the health and safety staff. Discharges at one dam were reduced to permit a construction company to move heavy equipment across the Little Tennessee River and to permit a farmer to remove a crop from an island. Special operations were undertaken at times to refloat craft stranded outside the navigation channel.

A small electronic digital computer was installed and used by the water control staff for the first time during the fiscal year in the solution of hydrologic problems and the execution of some river control procedures. Programmes were prepared and operated successfully on a production basis to compute, for example, mean daily stream discharge, water surface profiles, and current average daily rainfall for eighty-five subdivisions in the basin with data from nearly all the 200 reporting stations. The use of the computer has already increased production and improved accuracy of river forecasting at economical costs. The use of this computer is expected to lead to the use of a larger and faster computer, the I.B.M. 704, which was installed during the year, in the solution of hydrologic problems.

The primary purposes of the multiple-purpose system necessarily govern its operation. Nevertheless, they are not so inflexible as to prevent operations contributing to other beneficial uses of the reservoirs and their shores. The operation of the reservoirs for flood control, navigation and power generation may at times conflict with the fullest use of the reservoirs for recreation or fish and wild life development. At the same time, the lakes have provided a recreation asset many times more valuable and more usable than the original streams. The conditions created are far superior to the rivers in their original state for the propagation of fish and wild life. Moreover, the skilful management of the flow of water in the system has enabled thoroughgoing control of the malaria mosquito. Malaria control measures, based fundamentally on the management of water levels, made possible by the dams and reservoirs, have virtually banished this debilitating disease from riverside areas, where it once afflicted a third or more of the people. Storage and release of waters in the regulation of flows for the primary purposes has at the same time provided more potable water for municipal consumption and greater, more reliable supplies for industry.

Fish and Wild Life

A development not clearly foreseen twenty-five years ago was the extensive growth of the fish and wild life population and its use for both recreation and commercial purposes. Sports fishing and hunting are among the leading attractions in recreation use of the lakes. At the same time, the Tennessee has become one of the leading inland rivers in the yield of commercial fish and it supplies most of the fresh water mussel shells used by the United States button industry. Even so, both sport and commercial fishing could be considerably expanded without injuring the resource. In T.V.A.'s earliest years, the knowledge of the biological life of man-made lakes or "impounded waters" was skimpy. It was freely predicted that particularly in the storage reservoirs, such as Norris, the wide fluctuations in water levels would inhibit greatly, if they did not destroy, the chances of fish spawning. It was believed that the scarcity of bottom vegetation would mean a shortage of food and it was claimed that the lakes would become "biological deserts." At that time, T.V.A. undertook basic studies of the fisheries possibilities of the lakes. By 1939 it had become apparent that fish did spawn successfully in the reservoirs and that this could be helped along by water level management. Whenever possible, without detriment to the major reservoir purposes, a constant level is maintained when the water temperature becomes favourable to spawning in the spring. A favourable food cycle became established in the reservoirs, with gizzard shad and other small species living on the plankton and in turn becoming food for the larger game species.

One of the most far-reaching changes resulting from the investigations was the elimination of closed fishing seasons, greatly enhancing the recreation value of the lakes. This action was taken by the States, which have jurisdiction over the waters as far as fish and wild life are concerned, but it was based chiefly on the investigations and findings of T.V.A. biologists in exploring the fisheries potentialities of the lakes. Prior to 1940, State fishing regulations set minimum size limits to protect young fish and closed seasons in the spring seeking to keep fish unmolested during the spawning season. By the early 1940s, however, the work of biologists had uncovered enough information to indicate that the regulations were unnecessarily restrictive. Population studies, creel censuses, tagging programmes, and growth rate studies, all indicated that most fish were not caught by fishermen but died natural deaths. They showed further that most of the game fish in T.V.A. waters grew almost twice as fast as those in northern waters and that they had a correspondingly short life span.

In 1944, the State of Tennessee, on the advice of the T.V.A., inaugurated a year-round fishing experiment on Norris Lake. The annual closed season of two months, during the period when fishing was at its best, was abolished. The experiment was a success. Many more fish were caught, but the drain on the fish population was not appreciable and certainly not detrimental. By 1945, practically all of the 600,000 acres of water surface in the T.V.A. impoundments were open to year-round fishing. Subsequent investigations have continued to confirm that year-round fishing has not been injurious. Tagging studies, commenced in 1941 on Norris with the co-operation of fishermen, have been used

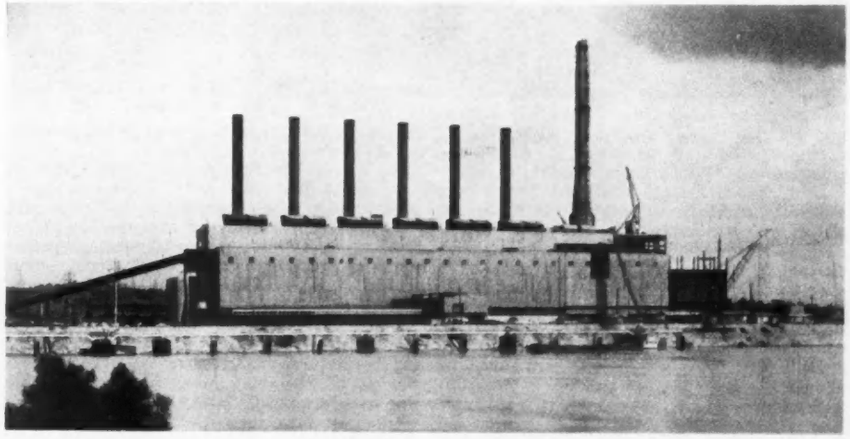


Fig. 9—Johnsonville steam power station on the Kentucky Lake in Tennessee, with a 750MW total present capacity

primarily to estimate the relative harvest of fish. The percentage of fish recaught in the various studies has ranged from less than 1 per cent to more than 40 per cent, but they have supported the general conclusion that less than 20 per cent of the sports fish in the reservoirs are harvested by fishermen ; most fish still die natural deaths. Tagging studies likewise reveal information on the migration and distribution of fish in reservoirs and on the relative ease with which different species may be caught. Findings in connection with the T.V.A. impoundments led to changes elsewhere. Many States eliminated closed seasons on other waters under their jurisdiction, and the results were noted and had influence in areas removed from the Valley region. An analysis of fishing regulations in forty-eight States in 1953 showed that twenty-three permitted bass fishing at any season ; thirty-seven permitted year-round pan fishing ; nineteen had no legal limits on the size of bass ; forty-three had no size limit on pan fish ; two had no bass creel limit ; and twenty-one had no creel limit on all or most of the pan fish.

Power Generation

An interplay of economic cross-currents made 1958 a typical year with regard to the T.V.A. power programme. Despite a year of business setbacks nationally, sales of electricity to all classes of customers except U.S. Government agencies increased. The large industries served directly by T.V.A. and the municipal and co-operative distribution systems which constitute the retail segment of the power system both showed gains. Particularly spectacular was the 23 per cent increase in residential sales ; the normal pattern of increase was augmented by abnormally cold weather requiring more electricity for heat. On the other hand, the Atomic Energy Commission, whose Oak Ridge and Paducah plants receive most of their electricity from T.V.A., sharply curtailed its short-term purchases. Generation was affected by the unusually favourable rainfall and run-off conditions. A record hydro-electric generation of 19,300 million kWh permitted important savings in the amount of coal burned at power stations.

The conditions on the T.V.A. power system as it is to-day are so greatly different from the conditions of electric service prevailing in 1933 that comparisons become meaningful only against the background of its growth. In scope of service, in volume of production and sales, and in operating policies, vast changes have taken place. In 1933, the electric energy output in the region now served by T.V.A. was only about 1500 million kWh. By 1950, when South Korea was invaded by the Communists, generation reached 17,500 million kWh. Since 1950, power generation in the region has multiplied more than threefold, chiefly as a result of the demands of atomic energy plants operated for national defence. The tremendous growth thus represents the influence of a number of factors which include the original Congressional purpose that electricity produced at the multiple-purpose dams be distributed widely and at low rates and applied to " fuller and better balanced development of the resources of the region." They include the heavy demands resulting from World War II and the subsequent industrial development which has taken place in the South-east, including the Tennessee Valley. Finally, they include the demands for national defence power resulting from the Korean conflict and the continuing cold war.

In the T.V.A. Act, the Congress expressed particular concern that electricity produced at T.V.A. projects should be considered as primarily " for the benefit of the people of the section as a whole and particularly the domestic and rural consumers to whom power can be economically made available." The policy has been carried out through the co-operation of the T.V.A. and the 150 locally-owned and -managed municipal and co-operative distribution systems, together with two small privately owned electric companies. In 1933, only one home in five in the 80,000 square miles now supplied with T.V.A. power had electric service. Of the 450,000 farms in the region, only 15,000 had electricity. In this respect, the Valley region lagged behind the rest of the country, in which rural service was far from extensive. Where 11 per cent of the American farms were electrified in 1933, the proportion of the Valley region was only a little over 3 per cent. The homes and farms that had electricity used it meagrely, at a rate averaging about 600kWh a year. This was the approximate rate of residential usage in the country. Lights and a radio were usual, refrigerators less common, and electric ranges and water-heaters found only occasionally. The prices of appliances were high and the cost of electricity to operate them was even higher. In the whole of the present region there were about 275,000 electricity consumers, of which 225,000 were residential.

In order to carry out the purposes of the Congress, T.V.A. embarked on several related courses. It established electric rates which were at least 50 per cent below those generally prevailing in the region. The new rates were frankly promotional. They were intended to stimulate a rapid growth in the use of electricity which would spread the costs over a larger number of kilowatt-hours and so reduce unit costs to profitable levels. The economics of mass production, induced by a mass market, were to be tested in an electric power enterprise. In two fields T.V.A. participated in pioneering ventures which registered important gains in the industry as they spread to national scope : (1) T.V.A. sought to make electric appliances available at lower cost. After consultation with neighbouring private utilities, T.V.A. organised the Electric Home and Farm Authority to work with manufacturers to develop low-cost appliances and to provide inexpensive financing for their purchase. These were pioneering steps, and not confined to the region. Within a short time, a national Electric Home and Farm Authority was set up to finance electric appliances, with loans to be repaid by monthly additions to electric bills. Private dealers and electric utilities were the major users of the service. (2) Aid was also extended to rural people in organising electric co-operatives. T.V.A. helped design new, low-cost rural lines, and helped these new distributors of power finance and build them.

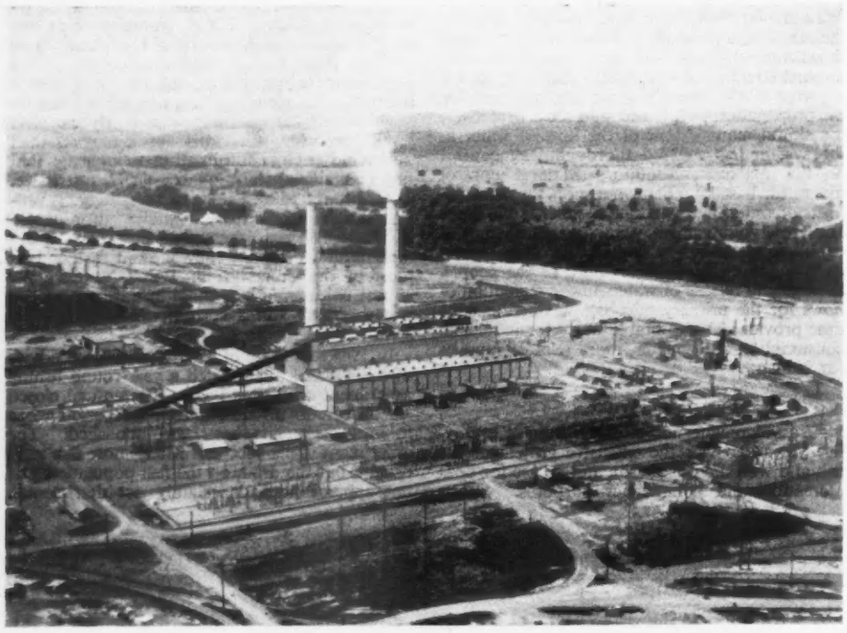


Fig. 10—John Sevier steam power station on the Holston River in Tennessee, with an 800MW total present capacity

The great expansion in power use in the region came after the last war was over. In this period of rapid growth, residential and farm use of electricity increased more than eleven-fold, from 843 million kWh in fiscal year 1945 to 9500 million kWh in fiscal year 1958. The proportion of the region's farms served increased from about 25 per cent to more than 95 per cent. The average residential use of electricity increased from less than 2000kWh per customer to nearly 7200kWh per customer, well over double the national average. In the fiscal year 1958, total sales of the distributors amounted to 17,700 million kWh to 1,509,000 residential, farm, commercial and industrial consumers. In 1945, their 586,000 consumers used less than 3000 million kWh.

The gross income from power operations in the 1958 fiscal year was 233·5 million dollars, down 2,200,000 dollars from 1957. The net income was 55,000,000 dollars, some 3,100,000 dollars less than the previous year. The net represented a return of 3·6 per cent on the 1530 million dollar average investment in the power system for the year. Throughout twenty-five years of operation the return has averaged about 4 per cent annually. The reductions in gross and net income this year were due principally to a decrease in power purchased by the Atomic Energy Commission, which reduced its short-term purchases by about three-fourths. The A.E.C. has long-term contracts with T.V.A. for 3,125,000kW of power, but it has been taking additional amounts under short-term agreements. Increased sales to the municipal and co-operative distributors and to directly served industries made up for most of the decline in revenues from Federal agencies. Revenue from sales to the distributors increased 10 per cent to 80,700,000 dollars. The most striking aspect of this increase was a 23 per cent gain in the energy sold by the distributors for residential use, with a 14 per cent gain in revenues from this source. This was partially offset, however, by less than average growth in use by commercial and industrial users. Sales to the two dozen large industries directly served by T.V.A. increased by 3,200,000 dollars. While some of the industries reduced their demands for power on account of the recession, these were more than offset in the greater purchases by several metals and chemical companies.

The total expense of power operations amounted to 178·6 million dollars, an increase of about 1,000,000 dollars over the year before. Fuel cost for the steam-electric power stations was 77,500,000 dollars, a reduction of 6,500,000 dollars from the year before. Excellent water conditions, which increased hydro-electric generation to record levels, was a major factor in the reduction of fuel costs. A slight decrease in the cost of coal also contributed.

Total generation for the year 1958 was 60,800 million kWh and was adequate to meet all loads. A record 19,300 million kWh came from the hydro-electric plants, enabling the steam power

stations to operate on a reduced scale. Steam generation was 41,500 million kWh, as compared with 44,700 million kWh the year before. The total input of the system, including 1400 million kWh of interchange power from other utility systems, totalled 62,200 million kWh. Rainfall and run-off were above normal for most of the year, with the result that the hydro-electric system was heavily loaded most of the time. In fact, during certain periods—January, February, late March and early April—the hydro-electric system was used for base load operation, thus reversing the normal parts of hydro-electric and steam power on the system.

The reservoirs were 76 per cent full as the fiscal year began, a high level for that period, while ground water levels were also high. These factors, as well as adequate steam capacity, made it possible to maintain a satisfactory level of hydro-electric production during two low rainfall months—July and August. September rains totalled 7·7in above Chattanooga, where most of the storage reservoirs are situated, and the water supply was ample from then to the end of the year. In fact, although the hydro-electric system generated more than 2200 million kWh in December, a record for any single month, it was necessary to spill water at some of the tributary dams instead of running it through the turbines in order to bring the reservoirs down to flood control levels. As a result of good hydro-electric conditions, it was possible to meet the system loads at times with several of the large new steam-electric units shut down. Only limited use was made of the four Widows Creek units without a reheat cycle, and the use of the units at the Colbert and John Sevier power stations was limited at times. It was also possible to keep units out of service for longer periods for regular maintenance, thus reducing overtime labour costs.

With reduced steam-electric generation, the system heat rate rose slightly, but it remained well below the 10,000 B.Th.U. level. The average number of B.Th.U. required per net kilowatt-hour generated was 9760, compared with 9705 the year before. The following table gives the fuel statistics for the major steam power stations.

Power Station	B.Th.U. per kilowatt-hour net generation	Mills* per kilowatt-hour net generation	1000 tons of coal consumed	
			1958	1957
Shawnee	9840	1688	4849	4793
Colbert	9470	1838	1903	2205
Gallatin	9530	1853	1193	608
Johnsonville ... (Fig. 9)	10,170	1848	2074	2369
John Sevier ... (Fig. 10)	9450	1967	1450	1662
Kingston	9770	1981	4326	4699
Widows Creek ...	9790	2040	1223	1904

* 1 Mill = 0·001 dollar.

The distributors of T.V.A. power had an outstanding year, with total sales of 17,700 million kWh, representing a 13 per cent increase over the year before. A total of ninety-nine municipal systems, fifty-one co-operatives, and two small private companies were serving 1,509,000 customers at the close of the year. Outstanding in the year's operation was the growth of residential sales, which increased 23 per cent to 9500 million kWh. The increase in residential use of electricity was primarily due to a severe winter and the resultant heavy use of energy for electric heat. More than 200,000 homes in the area are heated electrically, constituting about half the total of such homes in America.

The high use for electric heating also contributed to the great increase in average residential use. The average use per customer of 7189kWh represented a gain of 1166kWh over the figure for the previous fiscal year. The average cost per kilowatt-hour for residential service was 1·07 cents. In the United States average annual use per customer for the fiscal year 1958 was 3290kWh, an increase of 227kWh, and the average cost per kilowatt-hour was 2·53 cents.

High residential sales and revenues more than compensated for the fact that commercial and industrial sales did not increase as much as usual. The increase over 1957 was only 2·6 per cent. This was due largely to reduced use in the latter half of the year by industries affected by the general business recession. Total sales by the distributors to businesses and industries with demands greater than 50kW amounted to 5900 million kWh, an increase of about 1 per cent over the previous year.

One development in the fiscal year 1958 was the extension of research and demonstration in electric grain-drying installations, conducted in co-operation with the Middle Tennessee State College and the University of Tennessee experimental farms. In one of the University of Tennessee installations, grain products need no handling from harvest time to feeding time; grains are put into steel drying bins, dried, carried to the feed grinder or crimper and finally to a feed mixer—all automatically by electrical equipment. The electric grain drier, as modified by T.V.A. agricultural engineers to meet the needs of individual farmers, has been installed on about twenty-five farms, most of them in the past year. They have attracted wide interest. In these installations, the electric grain drying unit consists of a fan and electric heating equipment controlled by a humidistat. T.V.A. engineers are now working with manufacturers to design a complete unit for the market.

Much of the American pioneering work in the use of electricity for space heating in homes and commercial establishments has been done in this area. The original T.V.A. rate schedules provided for the use of electricity for space heating in addition to the promotion of use of such electric appliances as refrigerators, water heaters, washers and driers. Electric house heating got one of its first major try-outs in the town of Norris, built by T.V.A. to house workers engaged on the Norris dam construction scheme. Since then numerous studies have been made on the advantages of electric heating from the standpoint of both the power consumer and the power system. A "Guide for Calculations of Electric Space Heating," prepared by T.V.A., has been used widely throughout the Valley region by several electrical manufacturers, and by the National Electrical Manufacturers' Association. Assistance has been given to manufacturers in estimating the potential size of the heating appliance market and in developing methods for encouraging the use of electricity for space heating. The attitudes of utility systems concerning space heating have been undergoing change. Once thought to be applicable only in relatively mild climates, the interest in promotion of electric heat is now becoming nation-wide. Increasingly, the American utility systems have become interested in the development of space heating loads, and engineers from all parts of the country have consulted with T.V.A. on the subject. One of the reasons is the tremendous new market for electricity which space heating offers, and another is the contribution which such loads can make to the efficient operation of a grid system.

(To be concluded)

Radio Transmission into Buildings

INVESTIGATIONS have been made by Bell Telephone Laboratories, Inc., of the propagation into buildings of radio signals transmitted on 35 and 150 Mc/s. The tests, undertaken in connection with plans for a personal radio signalling service to subscribers using small pocket-carried receivers, were described in detail in the January, 1959, issue of *The Bell System Technical Journal*. Losses encountered in propagating an r.f. field into a building were measured at eleven different locations in New York City. Most of the measurements were taken at different points on the main floor of each building, the first floor having been found the most difficult position of a building to cover. For a given distance from the transmitter, the difference between the median field intensity in the streets and the field intensity at a point on the main floor is defined as the building loss. Thus building loss is a factor which can be applied to the field intensity in the streets to assist in the prediction of the performance of a radio service in buildings.

At 35 Mc/s the overall average building loss was found to be about 24 dB; at 150 Mc/s it was found to be about 22 dB. Variations in signal were found to be slightly greater at the lower frequency than at the higher—a reversal of what is found in city streets. It appears reasonable to expect ranges of communication into buildings of almost 1 mile at 35 Mc/s and almost 1½ miles at 150 Mc/s, using a 250W transmitter and a pocket-carried receiver with a sensitivity of 30 dB greater than 1 microvolt per metre. In contrast, the useful range in city streets was found to be greater at 35 Mc/s than at 150 Mc/s. Service could be provided in streets over a radius of about 8 miles at 35 Mc/s and 4 to 5 miles at 35 Mc/s.

It became apparent during the measurement of r.f. field intensities in buildings that their geometry was exceedingly complex. Variations as great as 20 dB were encountered between locations a few feet apart. As a result of the physical surroundings in a building, the field not only encounters varying degrees of attenuation in reaching a particular location, but it also arrives over a multiplicity of paths with random phase and random polarisation. Attempts to classify the "lossiness" of certain buildings according to architectural characteristics led to contradictory results. While three buildings in which local mean losses were below 20 dB at both frequencies had high ceilings, large windows and large unobstructed areas on their main floors, a fourth with similar characteristics presented a mean loss of 25 dB at 150 Mc/s and of over 30 dB at 35 Mc/s.

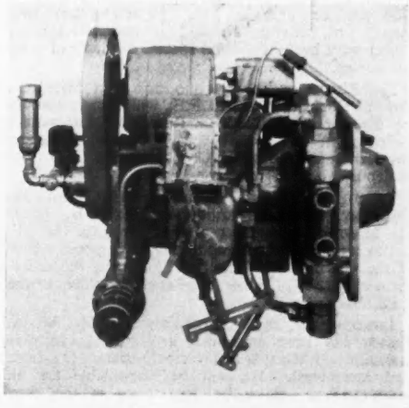
Rotary Atomisers

SWINNEY BROTHERS, Ltd., Wansbeck Iron Works, Morpeth, have reached agreement with the General Metals Corporation of the United States to manufacture in Britain the "Enterprise" rotary oil burner.

These burners, to be called Swinney-Enterprise rotary burners, are of the horizontal, belt-driven rotary cup type. There are twelve different sizes, covering all outputs normally required for the firing of shell, sectional and water-tube boilers, and they have maximum outputs from 3·5 to 167 gallons per hour. Realistic turn-down ratios of approximately 4 to 1 are claimed with good performance, high CO_2 and low smoke numbers throughout the operating range.

The burners are available for operation on natural, induced and forced draught, with liquid fuel up to the heaviest grades, and with manual operation, semi-automatic control or fully automatic control. With the two latter systems, fully modulating or high-low operation can be provided for all sizes. Automatic on-off operation is limited to burners up to a maximum output of 25 gallons per hour. For fully automatic operation, electro-gas ignition is provided, the supply of gas for this purpose being either from mains supply or liquefied petroleum gas.

One of the interesting features of the "Enterprise" burners is the incorporation of a variable output fuel metering pump. This ensures that the quantity of fuel supplied to the burner throughout its output range is independent of changes in oil supply pressure or temperature. Further, when the viscosity of the fuel delivered into the customer's storage tank changes on delivery, it is impossible for the air-fuel ratio to be changed, thus avoiding smoke being emitted. It is believed that this is the first rotary burner with such a device to be marketed in Britain.



"Enterprise" burner complete with control and ignition equipment

Personal and Business

Appointments

MR. R. A. LE PAGE has been appointed managing director of Mancuna Engineering, Ltd.

MR. F. A. FIELD has been appointed industrial contracts manager of Black and Decker, Ltd.

MR. R. F. HUNT, a director of Dowty Group, Ltd., has been elected deputy chairman of the company.

MR. W. GAY has been appointed technical representative, northern counties, for Mackay Industrial Equipment, Ltd.

MR. S. BENNETT has been appointed a director of T. C. Thompson and Son, Ltd. He will continue as works manager.

G. AND J. WEIR HOLDINGS, Ltd., announces that Mr. Iain M. Stewart and Mr. John H. Lord have been appointed directors.

MR. A. T. MAYNE has been appointed general manager in the Middle East for Taylor Woodrow (Building Exports), Ltd.

MR. J. E. T. WATSON has been appointed general sales manager of the construction equipment division of British Northrop, Ltd.

MR. LAURENCE MALEK has joined the Solartron Electronic Group, Ltd., as managing director of Solartron Radar Simulators, Ltd.

MR. J. M. M. WINKELMAN has been appointed sales and technical representative of Alfred Ellison, Ltd., for grey iron castings in London and the home counties.

MR. PETER BOULTON has been appointed general manager of Lansing Bagnall, Ltd. He will also control the management of the associate company, J. E. Shay, Ltd.

THE BRITISH IRON AND STEEL RESEARCH ASSOCIATION announces that Mr. E. W. Voice, head of the ironmaking division, has been appointed an assistant director of B.I.S.R.A.

MAJOR-GENERAL SIR FRANCIS DE GUINGAND and MR. E. L. BURTON have been appointed directors of Tube Investments, Ltd. Mr. Burton will continue to be secretary of the company.

MR. R. GROSVENOR has joined the recently formed Electronic and Mechanical Engineering Company, Ltd., Beecher Road Works, Cradley, Staffs, and will be responsible for technical inquiries and sales.

MR. W. J. ROBINSON, M.I.Mech.E., has been appointed chief engineer of British Pitometer Company, Ltd., an associate company of the Glenfield Group. This vacancy was caused by the death of Mr. James Lennox.

METROPOLITAN-VICKERS ELECTRICAL COMPANY, Ltd., announces that Mr. A. Cormack has been appointed superintendent (special duties), Larne Works, and Mr. R. Harrison has been appointed assistant superintendent, Germiston Works.

MR. N. C. MACDIARMID, managing director of the Stanton Ironworks Company, Ltd., and a member of the executive committee of the Joint Iron Council, has been elected chairman of the Council of Iron Producers in succession to Sir Frederick Scopes.

GEO. SALTER AND CO., Ltd., has announced that Mr. Brian M. Morgan has been appointed to represent the company's engineering divisions in the east Midlands, and Mr. I. C. Stevenson, in the southern counties (north of the Thames) and E. Anglia.

DORMAN, LONG AND CO., Ltd., announces that Mr. W. L. Fletcher has been appointed a director of Dorman, Long and Co., Ltd., and of Dorman Long (Steel), Ltd. Mr. E. N. Highton and Mr. George Foster have been appointed special directors of both companies.

THE BOARD OF TRADE announces that Mr. John Clifford Duckworth, A.M.I.E.E., will become managing director of the National Research Development Corporation on April 1. Mr. Dennis Hennessey has been appointed by the Corporation to a new post of deputy managing director.

THE BRITISH AND COMMONWEALTH SHIPPING COMPANY, Ltd., has announced that Mr. James Pinkerton, chief engineer of the "Pretoria Castle," has been appointed commodore chief engineer officer of the Union-Castle Line fleet, following the retirement of Mr. T. P. Noble, chief engineer officer of the "Edinburgh Castle."

LONDON TRANSPORT announces that Mr. W. A. Hissey has been appointed a principal executive assistant with the title of principal assistant (methods and incentives). He will be responsible for all investigations within the department of the chief civil engineer designed to increase productivity through method studies and incentive bonus schemes.

Business Announcements

SIR ALEXANDER KILLICK is to retire from the secretaryship of the Royal Institution of Chartered Surveyors on March 31.

SIMMONDS AEROCESSORIES, Ltd., announces that Mr. R. Goodburn, Surform export sales manager, is visiting agents and customers in Belgium during March.

HALL ENGINEERING, Ltd., states that its central sales office has been moved from Holborn Viaduct to 60, Rochester Row, London, S.W.1 (telephone, Victoria 5631).

CVA SMALL TOOLS, Ltd., announces that its London office has been moved from 161, Victoria Street, London, S.W.1, to 48, High Street, Edgware, Middlesex (telephone, Edgware 4488).

WHITLOCK BROTHERS, Ltd., states that plans have been approved for building a 50,000 square foot extension to its works at Great Yeldham, Essex, together with an additional access road.

THE OPERATIONAL RESEARCH SOCIETY has moved into an office of its own at 64, Cannon Street, London, E.C.4 (telephone, City 1800). Miss G. M. Heselton has been appointed secretary of the Society.

THE INSTITUTION OF PUBLIC HEALTH ENGINEERS has moved from 118, Victoria Street, and has obtained temporary accommodation, c/o Portman Building Society, 39, Portman Square, London, W.1 (telephone Welbeck 0981, Extension 30).

HENRY WIGGIN AND CO., Ltd., is staging a private electrical exhibition at the Engineering Centre, Stephenson Place, Birmingham, 2, from March 24–26, inclusive. Two sections will deal respectively with the properties of Wiggin nickel alloys and the design of electrical equipment using Wiggin materials.

SOUTHERN AREAS ELECTRIC CORPORATION, Ltd., 28, Queen Anne's Gate, Westminster, London, S.W.1, has announced that two of its subsidiary companies, Tyer and Co., Ltd., and P.A.M., Ltd., have been merged. In effect, states the Corporation, Tyer and Co., Ltd., has taken over P.A.M., Ltd. The Dalston factory of Tyer has been closed and that company has moved to the modern factory of P.A.M., Ltd., Merrow, near Guildford.

PANELEC (GREAT BRITAIN), Ltd., 21, Bloomsbury Street, London, W.1, announces that its activities will be integrated with those of the parent company, British Insulated Callender's Cables, Ltd., on March 30. From that date Panelec will operate as the heating division of British Insulated Callender's Cables, Ltd., and will assume full responsibility for the supply, sales and associated technical services for all heating systems, heating cables, &c., produced by the company.

Contracts

WILLIAM OLD, Ltd., Harrow, Middlesex, has been awarded a contract by London Transport for civil engineering work at Amersham (Metropolitan Line) and other stations. Its value is more than £125,000 and the work is due for completion in seventeen months.

LESLIE AND CO., Ltd., has been awarded by Newcastle-on-Tyne City Council a contract valued at more than £1,000,000, for three fifteen-storey and three twelve-storey blocks of flats to be built in Shieldfield, Cruddas Park and Heaton Park Road, Newcastle-on-Tyne. The consulting engineers are Messrs. John Liversedge and Associates.

TAYLOR WOODROW (BUILDING EXPORTS), Ltd., has been awarded contracts worth nearly £100,000 by Merritt Chapman and Scott Corporation and Associates, Ltd., of New York, the main contractor engaged in the development programme of the National Iranian Oil Company. A series of Arcon steel-framed prefabricated buildings is being supplied. The main consultants for the project are Mr. A. C. Hartley, in association with Messrs. Rendel, Palmer and Tritton.

THE FAIREY AVIATION COMPANY, Ltd., and KAMAN AIRCRAFT CORPORATION have announced the completion of negotiations to supply by the early spring of 1964 five "Rotodyne" airliners to New York Airways. The aircraft will be fifty-seven passenger machines with Rolls-Royce "Tyne" engines: they will be built in the United Kingdom, cost about £500,000 each, and gross 50,000 lb each. The 5000 h.p. free-turbine engines will apparently be installed very much like those of the prototype machine, with exhaust ducts in the nacelle sides and the tip-jet intakes in the upper surface of the wing. The fins erect completely, as on the modified prototype.

MASSEY-FERGUSON (LONDON), Ltd., and F. PERKINS, Ltd., have announced the receipt of an export order to supply Yugoslavia with £3,700,000 worth of agricultural machinery. The order is for 5000 Massey-Ferguson tractors and a wide range of implements, accessories and spare parts to be delivered to Industrija Traktora i Masina, of Belgrade. All the tractors will be fitted with engines manufactured by F. Perkins, Ltd. Deliveries are to start immediately and the orders will be completed within twelve months. The order for engines has been placed with F. Perkins, Ltd., by Industrija Motora, of Belgrade, and the Massey-Ferguson agreement was signed last week by Mr. S. Milivojevic, general director for Industrija Traktora, and by Mr. Arthur Whiteley, assistant managing director, on behalf of Massey-Ferguson.

THE NORTH OF SCOTLAND HYDRO-ELECTRIC BOARD has placed the main civil engineering contracts for the construction of its Strathfarrar and Kilmorack scheme (Constructional Scheme No. 30, see THE ENGINEER, March 8, 1957, page 367). The published cost of the scheme was £14,000,000 and the value of the contracts placed is a considerable proportion of this sum. The scheme will produce annually 268 million units of electricity. The Mitchell Construction Company, Ltd., has been awarded the contracts for the construction of the Monar dams, the Deanie tunnel and the Culligran tunnel and power station. Duncan Logan (Contractors), Ltd., have been awarded the contracts for the construction of the Beannachran dam and the Misgeach aqueducts. A. A. Stuart and Sons (Glasgow), Ltd., will construct the dams at Aigas and Kilmorack and the power stations which are integral parts of these structures. Riley and Neate, Ltd., has been awarded a contract for the erection of the 132kV transmission line which will carry the output of the power stations to the Highland grid near Beauly. The construction of these works is expected to start soon. The civil engineering consultants are Sir William Halcrow and Partners; the electrical and mechanical consultants are Messrs. Kennedy and Donkin.

Miscellanea

PROPOSED DOMESTIC APPLIANCES DIVISION OF THE BEAMA.—We learn that the BEAMA council is in process of establishing a Domestic Appliances Division under a divisional board to co-ordinate the activities of the BEAMA Sections in this field. The purpose is to promote the further development of this rapidly expanding side of the electrical industry.

STEEL STRIP SHEAR AND CLASSIFIER DRIVES AT VELINDRE.—We wish to clarify the references made in the article on page 295 (February 20, 1959), to the contractors mentioned as being responsible for the electrical drives at Velindre. Whilst the drives for the tinning lines were supplied by The General Electric Company, Ltd., the electrical equipments for shearing and classifying of both the tinned and "black" strip (described in the article) were supplied by Harland Drives, Ltd. Collaboration between the two companies mentioned was required only where the shear and classifier section drives, supplied by Harland Drives, Ltd., followed the tinning lines, the drives for which were supplied by The General Electric Company, Ltd., and this collaboration was arranged by McLellan and Partners.

MANCHESTER SHIP CANAL.—The annual report for 1958 of the Manchester Ship Canal Company shows that almost 18,000,000 tons of traffic was handled in the canal and the Queen Elizabeth II oil dock during the year, that is to say about a million tons more than in 1957, but 500,000 tons less than the peak year, 1956. At the company's annual general meeting held on February 27, the chairman, Sir Leslie Roberts, reviewed the year's work and the problems facing the company. One of these problems, which is of a technical nature, concerns dredging the approaches of the Ship Canal and the Queen Elizabeth II oil dock. Maintenance of a satisfactory approach channel had continued to be difficult, Sir Leslie pointed out, and the total dredging bill represented almost 45 per cent of the company's total expenditure. The Hydraulics Research Board had now completed the construction of the model of Liverpool Bay, he went on, and was carrying out tests on both that model and a large-scale model of the Upper Estuary of the River Mersey. It would be some time before the final results of the experiments could be ascertained, but he still hoped that those results would enable some solution to be found towards mitigating the difficulties which Merseyside dock interests had experienced during the last four years.

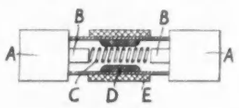
British Patent Specifications

When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings, unless otherwise stated. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification. Copies of specifications may be obtained at the Patent Office Sales Branch, 15, Southampton Buildings, Chancery Lane, W.C.2, 3s. 6d. each.

ATTENUATORS

807,727. February 17, 1956.—ATTENUATION DEVICES FOR VERY-HIGH-FREQUENCY WAVE ENERGY, Siemens and Halske Aktiengesellschaft, of Berlin and Munich, Germany.

The invention is concerned with the problem of finding a simple way of attenuating very-high-frequency waves travelling along a coaxial transmission line so that the attenuation will depend upon the direction of propagation. The invention is based on the realisation that a coaxial line with a helical inner conductor differs from a con-circularly polarised wave component, the direction of rotation of which depends upon the direction of propagation, so that it can be used to produce the gyromagnetic effect. In the embodiment of the invention illustrated in the drawing there are two coaxial plug connectors *A*, one at each end of a length of coaxial line. *B* is the inner conductor of the coaxial line and is in the form of a helix *C* in the central portion of the line. *D* is a small ferrite tube with flared ends and *E* indicates means for magnetising the ferrite member—for instance, a coil which carries a current. This current-carrying coil may be replaced by a permanent magnet or magnets,



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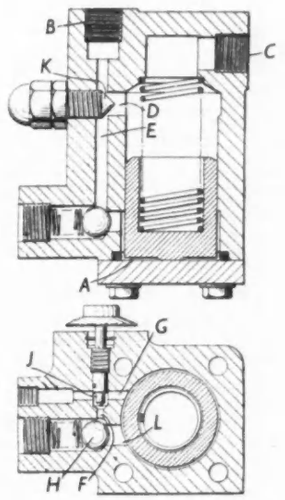
which may be preferred if variation of the attenuation in either direction is not required. Even then the absolute attenuation may still be varied by the provision of a magnetic shunt. When a current-carrying coil is employed it may be used as a modulator by varying the energising current in relation to time. If an alternating voltage is applied to the field coil the very-high-frequency waves will be more or less attenuated according to the instantaneous magnitude and direction of the alternating voltage that is applied.

It has been found that a particularly low attenuation is obtained in the forward direction with a given attenuation value in the opposite direction by a special shaping of the attenuating element. For this purpose, the attenuating element is constructed as a hollow body whose transverse cross section at any point is circular. Instead of providing only one attenuating element several such elements may be arranged along the helical conductor. The use of several attenuating elements enables the best absolute values of attenuation and the required difference between the attenuation in the two directions to be obtained over a predetermined frequency range.—*January* 21, 1959.

HYDRAULIC ENGINEERING

808,501. August 4, 1955.—HYDRAULIC METERING DEVICE, Hamworthy Engineering, Ltd., Fleets Corner, Waterloo Road, Poole, Dorset. (*Inventor: Thomas Gray.*)

This specification describes an improved hydraulic metering device which is used for controlling the length of stroke of a piston in a cylinder, or for similar purposes. The device comprises a block in which a piston valve *A*, can make contact with a conical seat at the top end of the cylinder. A spring urges the piston away from its seat. The valve seat is set in a passage for pressure fluid, which enters the valve block through an inlet *B* and leaves at an outlet *C*. From the inlet a passage *E* extends parallel to the axis of the cylinder, and the port *D* connects the cylinder space with the passage *E*. The conical end of a screw forms a restriction between the passage and the port. The passage is extended and branched off from the lower end is a cross bore *F*, which is connected to another passage *G*, terminating in the cylinder at the end remote from the valve seat. The opening between the bore *F* and the passage *G* is controlled by a needle valve *J*. In this way, the rate of flow of pressure fluid from the branch line to the passage *G* and into the lower end of the cylinder can be controlled from outside. The needle valve *J* has a by-pass *L* which is normally shut by a non-return valve *H*. A main control valve (not shown) is placed between the source of pressure fluid and the inlet of the device. In operation, hydraulic fluid enters the inlet as soon as the main control valve is opened, and flows through the port *D* into the return end of the cylinder. From there it can freely pass into the outlet *C* as the piston valve *A* is retained away from the valve seat by its spring. A certain part of pressure fluid flows into the lower end of the cylinder at a rate



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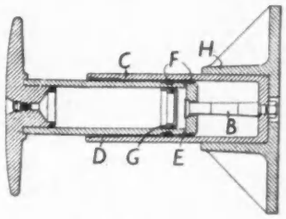
determined by the opening of the needle valve *J*. This fluid raises the piston valve at a speed set through the needle valve, until it reaches its seat. Thereupon, the passage of fluid to the outlet is closed. It will therefore be seen that the volume of pressure fluid delivered to a power cylinder through the device can be easily adjusted by the needle valve. The pointed screw end *K* is designed to produce a drop in pressure in the fluid passing through the port *D* below that of the fluid entering the lower end of the cylinder, so that the piston valve can overcome the force of its spring, and that of the fluid passing through the upper end of the cylinder. As pointed out before, the flow of fluid through the device to the power cylinder ceases as soon as the piston valve has engaged its seat. Flow of fluid to the passage *G* and working end of the cylinder, will, however, continue as long as the main control valve is open. There will therefore be a certain amount of pressure built up on the lower side of the piston valve so that it is firmly held on its seat. When the main control valve is closed the piston valve is returned to its initial position through the spring and the pressure on both sides of the piston valve is then equalised. The pressure fluid displaced from the working side of the valve during its return is transferred through the by-pass *L*, after the opening of the non-return valve *H*, and through the branch line and port *D* to the return side of the piston valve. It will be seen that as soon as the piston valve has reached its starting position, it is ready for another stroke. The device according to the invention can therefore be utilised for metering an uninterrupted succession of equal quantities of pressure fluid. This enables the control of a piston in a power cylinder so that it makes a number of strokes of equal length, without returning in between to its starting position. Alternatively, by moving the main control valve back into the "off" or "drain" position each time the piston valve in the device has reached its seat, the piston in the power cylinder will be caused to return to its starting position after each stroke.—*February* 4, 1959.

808,931. August 21, 1957.—BUFFERS FOR VEHICLES, Oleo Pneumatics, Ltd., Kenilworth, Warwick. (*Inventors: John Henry Onions and Peter Warborn Thornhill.*)

This invention relates to buffers in which impact energy is absorbed by displacing liquid through a controlled passage, the restoring force for extending the buffer after impact being provided preferably by compressed air,as described in our Specifications Nos. 703,855 and 721,222, although other resilient means, such as a spring, may be used. The object of the invention is to provide a construction which is relatively economical, but produces a strong and reliable



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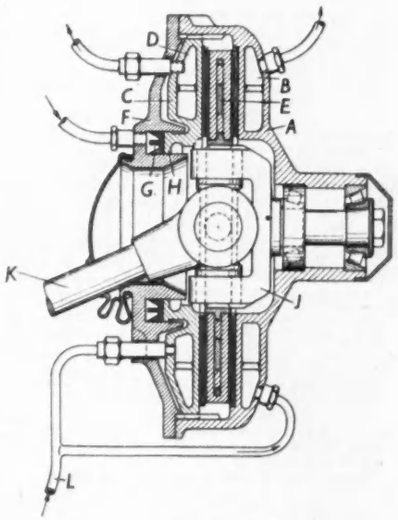
unit. Referring to the drawing, the closed end of a cylinder has a metering pin *B* secured in position by a nut. A tubular piston *C*, slidable in the cylinder, is closed at its inner end and apertured for the passage of the metering pin. The pin has a head which is too large to pass through the aperture and so forms an extension stop for the buffer. The outer end of the piston *C* is closed by a buffer head having on its rear a central shank which is a press fit in the piston. A bearing bush *D* is provided in the open end of the cylinder to engage the piston wall, and a second bearing bush *E*, mounted on the piston near its closed end, engages the internal wall of the cylinder. Packings *F* on the piston provide a fluid-tight joint with the cylinder. A floating piston *G*, slidable in the piston, divides the interior of the buffer into a liquid space partly in the cylinder and partly in the piston, and an air space in the piston. An inflation valve in the centre of the buffer head enables air to be pumped into the air space. The closed end of the cylinder is fitted into a tubular socket *H* of a headstock bracket which can be secured to the buffer beam. By forming both the buffer head and the headstock bracket separate from the tubular plunger and the cylinder respectively, a very considerable reduction of the metal required to be removed by machining is provided, thus reducing both material and labour costs. The socket *H* provides added strength to the cylinder at its rear end, where it is subjected to high internal pressures, and thus enables the cylinder to be made with a wall thickness less than would be required if it was unsupported.—*February* 11, 1959.

MOTOR VEHICLES

808,746. August 9, 1956.—BRAKES FOR VEHICLES, Daimler-Benz Aktiengesellschaft, Stuttgart-Untertürkheim, Germany.

One embodiment of a water-cooled brake with which this invention is concerned is illustrated in the accompanying drawing. A fixed brake housing *A* on the sprung frame or body of a motor vehicle has an annular cooling jacket *B*. A non-rotating brake disc *C*, with an annular cooling jacket *D* slides axially in the housing *A*. Located between the two plane-ground surfaces of the parts *A* and *C* serving as outer brake or pressure discs is an intermediate disc *E* which rotates with the wheel. A cover *F* on the housing *A* contains a brake cylinder *G* in which slides an annular piston *H* forming part of the slidable disc *C*. The intermediate disc *E* is connected to a joint



No. 808,746

piece *J* mounted in bearings and forming part of a cardan joint connection to the brake shaft *K*. Water from the cooling circuit of the engine of the vehicle passes from a pipe *L* into the cooling jackets and is conducted back to the engine from the upper parts of the jackets. For braking, the cylinder *G* is supplied with pressure oil to displace the brake disc *C* to the right, forcing the axially movable intermediate disc *E* against the fixed brake disc. The heat evolved is transmitted to the water flowing through the cooling jackets. The brake linings used are discs of metal, such as grey cast iron fused with the brake discs, which are preferably made of aluminium. The inner rotating disc *E* between the metal linings has a lining of conventional non-metallic material. By this means particularly favourable cooling conditions are created, since the heat evolved on braking is transmitted directly from the metallic linings to the cooled discs.—*February* 11, 1959.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office not later than a fortnight before the meeting. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

ASSOCIATION OF SUPERVISING ELECTRICAL ENGINEERS

Tues., March 17.—ALDERSHOT AND DISTRICTS BRANCH: Red Cross Hall, High Street, Aldershot, "The Nightstor Story," E. H. Parker, 7.30 p.m. ★ EAST KENT BRANCH: Clarendon Hotel, Broadstairs, Kent, "Electrical Safety," S. J. Emerson, 8 p.m.

Wed., March 18.—NOTTINGHAM BRANCH: Mechanics' Institution, Trinity Square, Nottingham, Open Forum, 7.30 p.m. ★ WOLVERHAMPTON AND DISTRICT BRANCH: Chamber of Commerce, District Bank Chambers, Lichfield Street, Wolverhampton, "Light Sources with Particular Reference to Electro-Luminescence," G. V. McNeill, 7.45 p.m.

Fri., March 20.—STOKE AND CREWE BRANCH: Grand Hotel, Hanley, "Cable Insulation," 7.30 p.m.

Sat., March 21.—YORK BRANCH: Visit to the Coal Carbonisation Plant, Askern Colliery, Doncaster, 10.30 a.m.

BRITISH INSTITUTE OF MANAGEMENT

Tues., March 17.—PRODUCTION CONTROL STUDY GROUP: Management House, Fetter Lane, London, E.C.4, "Production Control—Its Objectives and Organisation," E. L. Tuff, 2.30 p.m.

BRITISH INSTITUTION OF RADIO ENGINEERS

Thurs., March 19.—MEDICAL ELECTRONICS GROUP: London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1, "Instrumentation in Field Physiology," H. Wolff, 6.30 p.m. ★ SCOTTISH SECTION: Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, "Application of Magnetic Amplifiers to Electrical Switching," J. A. Purdie, 7 p.m.

Fri., March 20.—SCOTTISH SECTION: Department of Natural Philosophy, The University, Drummond Street, Edinburgh, "Application of Magnetic Amplifiers to Electrical Switching," J. A. Purdie, 7 p.m.

COMBUSTION ENGINEERING ASSOCIATION

Wed., March 18.—MIDLAND REGION: Room No. 3, Chamber of Commerce, New Street, Birmingham, "The Use of Small Coals for Steam Raising," E. Otty, 10 a.m.

Tues., March 24.—SOUTHERN REGION: St. Ermins Hotel, Westminster, London, S.W.1, "The Costing of Heat and Power," G. H. Buckle, 10.30 a.m.; "Capital Investment and Fuel Saving Schemes," R. H. Potterill, 2.30 p.m.

DIESEL ENGINEERS AND USERS ASSOCIATION

Thurs., March 19.—Institute of Marine Engineers, Memorial Building, 76, Mark Lane, London, E.C.3, "Development of the Vee-type Engine," G. Hopwood, 2.30 p.m.

ILLUMINATING ENGINEERING SOCIETY

Mon., March 16.—BATH AND BRISTOL CENTRE: Gardiner, Sons and Co., Ltd., Broad Plain, Bristol, "Airport Lighting," J. G. Holmes, 7 p.m.

Wed., March 18.—NORTH LANCASHIRE GROUP: Demonstration Theatre, North Western Electricity Board, 19, Friargate, Preston, Annual General Meeting; "Commercial and Industrial Lighting," A. Temple, 7 p.m. ★ TEES-SIDE GROUP: Cleveland Scientific and Technical Institution, Corporation Road, Middlesbrough, "Lighting in 1984," E. E. Miles, 6.30 p.m.

Fri., March 20.—BIRMINGHAM CENTRE: St. Mary's Hall, Coventry, "Architecture of Light," Rolf Helburg, 6 p.m.

INSTITUTE OF BRITISH FOUNDRYMEN

Tues., March 17.—SLOUGH SECTION: Lecture Theatre, High Duty Alloys, Ltd., Slough, "Mechanical Aids to Shell Moulding," D. H. Scott, 7.30 p.m.

Wed., March 18.—SOUTHAMPTON SECTION: Technical College, St. Mary's Street, Southampton, "Cupola Experiments," K. G. Harris, 7.30 p.m.

INSTITUTE OF FUEL

Wed., March 18.—YORKSHIRE SECTION: Metropole Hotel, Leeds, "Effluent Gas Cleaning," E. L. Brown, 2.30 p.m.

INSTITUTE OF MARINE ENGINEERS

Mon., March 16.—WEST OF ENGLAND SECTION: Smith's Assembly Rooms, Bath, "The Application of Nuclear Power to Marine Propulsion," H. W. Bowker, 7.30 p.m.

Tues., March 17.—SOUTHERN BRANCH: Technical College, St. Mary Street, Southampton, Joint Meeting with the Southern Branch of the Institution of Naval Architects, "Marine 'Proteus' Engines for 'Brave' Class Patrol Boats," B. G. Markham, 7.30 p.m. ★ JUNIOR LECTURE: Woolwich Polytechnic, London, S.E.18, "Petroleum Refining," E. H. Wild, 7 p.m.

Wed., March 18.—SCOTTISH SECTION: MacTaggart, Scott and Co., Ltd., Loanhead, Midlothian, "The Development of Some Seagoing Hydraulic Machinery," A. E. G. Clement and R. C. Russell, 5 p.m.

Thurs., March 19.—NORTH EAST COAST SECTION: Stephenson Building, King's College, Claremont Road, Newcastle upon Tyne, "Some Developments in the Design of Self-Priming Pumps for Marine Services," R. Warren, 6.15 p.m.

INSTITUTE OF NAVIGATION

Fri., March 20.—Royal Geographical Society, 1, Kensington Gore, London, S.W.7, "The Impact of Radar on the Rules of the Road at Sea," F. J. Wylie, 5.15 p.m.

INSTITUTION OF CHEMICAL ENGINEERS

Tues., March 17.—SPRING MEETING: Church House, Westminster, London, S.W.1, "Methods of Improving Heat Transfer from Condensing Steam and their Application to Condensers and Evaporators," D. C. P. Birt, J. J. Brunt, A. Met, J. T. Shelton and R. G. H. Watson; "Investigation of Air-Flow in a Spray-drier by Tracer and Model Techniques," G. Place, K. Ridgway and P. V. Danckwerts; "Entrainment in Turbulent Fluid Jets," M. B. Donald and H. Singer; "Entrainment in Evaporators," F. H. Garner, S. R. M. Ellis and D. B. Shearn, and "Purification of Hydrogen for Distillation: Part II," W. H. Denton, R. Gayler and B. Shaw, 9.30 a.m.

INSTITUTION OF CIVIL ENGINEERS

Fri., March 20.—1, Birdcage Walk, Westminster, London, S.W.1, Joint Meeting with the Institutions of Mechanical Engineers and Electrical Engineers, Graham Clark Lecture, "Engineering in an Expanding Economy," Professor Sir Arnold Plant, 6 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS

Mon., March 16.—LONDON GRADUATE AND STUDENT SECTION: Savoy Place, London, W.C.2, "Something for Nothing? Heat Pump Achievements," G. O. McLean, 6.30 p.m. ★ MERSEY AND NORTH WALES CENTRE: Town Hall, Chester, "H.V.D.C. Transmission with Special Reference to Cross-Channel Cable," F. J. Lane, 6.30 p.m. ★ NORTH-EASTERN RADIO AND MEASUREMENT GROUP: King's College, Newcastle upon Tyne, "Examples of Geoelectric Surveys," L. S. Palmer, 6.15 p.m. ★ NORTH MIDLAND CENTRE: Town Hall, Leeds, Faraday Lecture, "Automation," H. A. Thomas, 7 p.m. ★ SHEFFIELD SUB-CENTRE: Angel Hotel, Brigg, Lincs, Discussion on "Electrical Maintenance Problems in Factory and Supply Systems," 6.45 p.m. ★ NORTH STAFFORDSHIRE SUB-CENTRE: Technical College, Stafford, Joint Meeting with the Graduate and Student Section: Short Papers Evening, 7.15 p.m. ★ WESTERN SUPPLY GROUP: South Wales Institute of Engineers, Park Place, Cardiff, "Insulation and Insulation Testing," H. C. Tucker, 6 p.m. ★ READING DISTRICT BRANCH: George Hotel, King Street, Reading, "Subscriber Trunk Dialling," D. A. Barron, 7.15 p.m.

Tues., March 17.—MEASUREMENT AND CONTROL SECTION: Savoy Place, London, W.C.2, "Electrical Uses of Atomic Spin," G. Phillips, 5.30 p.m. ★ EAST MIDLAND CENTRE: E.M.E.B. Service Centre, Derby, "The Development of Variable-Speed High-Power Drives for Large Wind Tunnels," and "A Variable-Frequency Power Installation for Large Wind-Tunnel Drives," P. McKearney, L. S. Drake and E. G. Mallalieu, 6.30 p.m. ★ CAMBRIDGE RADIO AND TELECOMMUNICATION GROUP: Cavendish Laboratory, Free School Lane, Cambridge, "Reliability of Electronic Components," G. W. A. Dummer, 8 p.m. ★ NORTH-WESTERN UTILIZATION GROUP: Engineers' Club, 17, Albert Square, Manchester, "Electrical Installation at Calder Hall Nuclear Power Station," N. J. Mackay and E. Hardwick, 6.15 p.m. ★ WESTERN CENTRE: Technical College, Bath, "Electrification of the U.K.A.E.A. Industrial Group Factories," J. W. Binns and W. J. Outram, 6 p.m.

Wed., March 18.—RADIO AND TELECOMMUNICATION SECTION: Savoy Place, London, W.C.2, "New Amplifying Techniques," C. W. Oatley, 5.30 p.m. ★ NORTH-WESTERN RADIO AND TELECOMMUNICATION GROUP: Engineers' Club, Albert Square, Manchester, "Bridging the Atlantic," A. H. Mumford, 6.15 p.m. ★ NORTH LANCASHIRE SUB-CENTRE: North-Western Electricity Board Demonstration Theatre, Finckle Street, Kendal, "British Columbia-Vancouver Island 138kV Submarine Power Cable," T. Ingledew, R. M. Fairfield, E. L. Davey, K. S. Brazier and J. N. Gibson, 7.15 p.m. ★ SOUTHERN CENTRE: Grand Hotel, Bournemouth, "The Application of Transistors to Line Communication Equipment," H. T. Prior, D. J. R. Chapman and A. A. M. Whitehead, 6.30 p.m.

Thurs., March 19.—NORTH-EASTERN CENTRE: City Hall, Newcastle upon Tyne, Faraday Lecture, "Automation," H. A. Thomas, 7 p.m. ★ IRISH BRANCH: Physical Laboratory, Trinity College, Dublin, "Network Analysers—Why and Wherefore," W. P. Leech, 6 p.m.

Thurs. and Fri., March 19 *and* 20.—RADIO AND TELECOMMUNICATION SECTION: Savoy Place, London, W.C.2, Convention on "Stereophonic Sound Recording, Reproduction and Broadcasting," 9.30 a.m.

Fri., March 20.—FIFTH GRAHAM CLARK LECTURE: Institution of Mechanical Engineers, 1, Birdcage Walk, Westminster, London, S.W.1, Joint Meeting with the Institutions of Mechanical Engineers and the Civil Engineers, "Engineering in an Expanding Economy," Professor Sir Arnold Plant, 6 p.m.

Mon., March 23.—RADIO AND TELECOMMUNICATION SECTION: Lecture Theatre, Savoy Place, London, W.C.2, "High-Quality Microphones," M. L. Gayford; Tea Room, Savoy Place, London, W.C.2, "Effects of Argon Content on the Characteristics of Neon-Argon Glow-Discharge Reference Tubes," F. A. Benson, 5.30 p.m. ★ NORTH-EASTERN CENTRE: Neville Hall, Westgate Road, Newcastle upon Tyne, "The Selection of Insulation Levels and Tests for High-Voltage Transformers," G. B. Harper, 6.15 p.m. ★ SOUTH MIDLAND RADIO AND MEASUREMENT GROUP: James Watt Memorial Institute, Birmingham, "The History of B.B.C. Television," R. T. B. Wynn, 6 p.m. ★ WESTERN UTILIZATION GROUP: South Wales Institute of Engineers, Park Place, Cardiff, Informal Meeting, 6 p.m.

INSTITUTION OF ENGINEERING DESIGNERS

Sat., March 14.—NORTH-EAST BRANCH: Visit to Calder Hall Atomic Power Station, 3 p.m.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND

Tues., March 17.—39, Elmbank Crescent, Glasgow, "A General Review of Ship Hydrodynamic Research," F. H. Todd, 6.30 p.m.

Fri., March 20.—Robert Gordon's Technical College, Aberdeen, Joint Meeting with Aberdeen Mechanical Society, "Resistance and Propulsion of Single-Screw Coasters, Part IV, L/B = 5½," J. Dawson, 7.45 p.m.

INSTITUTION OF LOCOMOTIVE ENGINEERS

Wed., March 18.—Lecture Hall, Institution of Mechanical Engineers, 1, Birdcage Walk, Westminster, London, S.W.1, Annual General Meeting: "The Electrogyro Locomotive," T. E. Green and J. K. Gessler, 5.30 p.m.

Thurs., March 19.—Visit to British Railways, London Midland Region, Derby Locomotive Works, and to the Staff Training College, Derby, 1.10 p.m.

INSTITUTION OF MECHANICAL ENGINEERS

To-day, March 13.—WESTERN BRANCH: Technical College, Gloucester, "Numbers, Statistics and Computers in the Engineering Industry," H. McGregor Ross, 7.30 p.m.

Sat., March 14.—YORKSHIRE GRADUATES' SECTION: Visit to Cravens, Ltd., Darnall, 10 a.m.

Mon., March 16.—DERBY A.D. CENTRE: Rolls-Royce Welfare Hall, Nightingale Road, Derby, "The British Aircraft Industry," E. Bowyer, 6.15 p.m. ★ SCOTTISH A.D. CENTRE: Institution of Engineers and Shipbuilders, Glasgow, "Modern Engine Lubricating Oils," F. Lawrence, 7.30 p.m.

Tues., March 17.—LONDON AUTOMOBILE DIVISION: 1, Birdcage Walk, Westminster, London, S.W.1, James Clayton Lecture, "The Creation of a Country's Automobile Industry: The Engineer's Viewpoint," Wifredo P. Ricart, 6 p.m. ★ NORTH WESTERN A.D. CENTRE: Liverpool Corporation Passenger Transport Department, Liverpool, Symposium on "Petrol Injection," presented by E. W. Downing, 7.15 p.m. ★ COVENTRY GRADUATES' A.D. SECTION: Wine Lodge, The Burges, Coventry, "Air Services for Pneumatic Suspension Schemes," A. Wildigs, 7.30 p.m.

Wed., March 18.—NORTH EASTERN A.D. CENTRE: Chemistry Lecture Theatre, The University, Leeds, "Fatigue Testing in Vehicle Components," T. C. F. Stott, 7.30 p.m. ★ EASTERN GRADUATES' SECTION: W. H. Allen and Sons, Queen's Engineering Works, Bedford, "Corrosion of Heat Resisting Steels: Their Composition and Properties," J. T. Courlander, 7.30 p.m. ★ NORTH EASTERN GRADUATES' SECTION: Lecture-visit to B.O.C. Works, Grangetown, Middlesbrough, 2 p.m.

Thurs., March 19.—MIDLAND BRANCH: James Watt Memorial Institute, Great Charles Street, Birmingham, "Materials in the Service of Mechanical Engineers," R. G. Brown, 6 p.m. ★ NORTH WESTERN BRANCH: Engineers' Club, Albert Square, Manchester, "Special Design and Construction Features of the Bradwell Nuclear Power Station," G. H. Inglis, 6.45 p.m. ★ YORKSHIRE BRANCH: Royal Station Hotel, York, "The Jodrell Bank Radio-telescope," H. C. Husband, 7.30 p.m. EAST MIDLANDS GRADUATES' SECTION: College of Further Education, Greenclose Lane, Loughborough, "Practical Determination of the Moment of Inertia of Railway Vehicles," A. Rimmer, 7.15 p.m. ★ LONDON GRADUATES' SECTION: 1, Birdcage Walk, Westminster, London, S.W.1, "Some Aspects of High Temperature Pipework Design," A. A. Smith, 6.30 p.m. ★ YORKSHIRE GRADUATES' SECTION: Hotel Metropole, Leeds, Ladies Invitation Evening, "Home Laundry Equipment," 7.15 p.m.

Fri., March 20.—GRAHAM CLARK LECTURE: 1, Birdcage Walk, Westminster, London, S.W.1, Joint Meeting with the Institutions of Electrical Engineers and Civil Engineers, "Engineering in an Expanding Economy," Professor Sir Arnold Plant, 6 p.m.

Sat., March 21.—WESTERN GRADUATES' SECTION: Visit to Williams and James, Chequers Bridge, 10.30 a.m.

INSTITUTION OF MINING AND METALLURGY

Thurs., March 19.—Geological Society, Burlington House, Piccadilly, London, W.1, "Recovery of Semi-Heavy Minerals in Jigs," F. A. Williams; "Santa Barbara Mill, Chihuahua Mexico," D. C. Shelton, 5 p.m.

INSTITUTION OF PLANT ENGINEERS

Mon., March 16.—MERSEYSIDE AND N. WALES BRANCH: The Blossoms, Chester, Annual General Meeting; Film "Planned for the Purpose," 7.15 p.m.

Wed., March 18.—KENT BRANCH: Kings Head Hotel, High Street, Rochester, "Some Applications of Plastics in Industry," C. L. Childs, 7 p.m. ★ SOUTH WALES BRANCH: Park Hotel Cardiff, Annual General Meeting and Annual Dinner, 6.15 p.m.

Thurs., March 19.—PETERBOROUGH BRANCH: White Lion Hotel, Church Street, Peterborough, Annual General Meeting, 7.30 p.m.

Fri., March 20.—BIRMINGHAM BRANCH: Imperial Hotel, Temple Street, Birmingham, Annual General Meeting; Films, 7.30 p.m.

INSTITUTION OF PRODUCTION ENGINEERS

Mon., March 16.—EAST AND WEST RIDINGS REGION: Visit to David Brown Industries, Ltd., Park Gear Works, Huddersfield, 6.15 p.m. ★ MIDLANDS REGION: Craven Arms, High Street, Coventry, "The Mass Production of Forgings," R. E. Winch, 7.15 p.m.

Tues., March 17.—SOUTHERN REGION: Kings Head Hotel, Aylesbury, Bucks, "Chemicals and Plastics," 7.30 p.m.

Wed., March 18.—HALIFAX AND HUDDERSFIELD GRADUATE SECTION: Percival Whitley College of Further Education, Halifax, "The Production of Power from Nuclear Energy," A. L. Shaw, 7.30 p.m. ★ EASTERN REGION: Sexton Room, Assembly House, Norwich, "Development of Gear Hobbing Process," 7.30 p.m. ★ MIDLANDS REGION: Visit to The University, Birmingham, and Annual General Meeting, 7 p.m. ★ WOLVERHAMPTON GRADUATE SECTION: Wolverhampton and Staffs. College of Technology, Wulfruna Street, Wolverhampton, Annual General Meeting, 7 p.m.; Film Show, 7.30 p.m. ★ NORTH MIDLANDS REGION: Conference Room, Peterscourt, Peterborough, Annual General Meeting, 7.30 p.m.; Films, 8 p.m. ★ MANCHESTER GRADUATE SECTION: Reynolds Hall, College of Science and Technology, Sackville Street, Manchester, Annual General Meeting, 6.45 p.m., "Social Influences Affecting Industrial Output," T. Lupton, 7.15 p.m. ★ SCOTTISH REGION: North British Hotel, Edinburgh, "Job Evaluation and Wage Structure," A. S. Wilson, 7.30 p.m.; Annual General Meeting, 9.30 p.m. ★ LONDON GRADUATE SECTION: 10, Chesterfield Street, London, W.1, Annual General Meeting followed by film evening, 7.15 p.m. ★ S. ESSEX SECTION: The Hoffmann Manufacturing Company, Ltd., Social Centre, New Street, Chelmsford, Annual General Meeting, 7.30 p.m. ★ WALES REGION: Central Library, Swansea, "Properties of Pure Molybdenum Disulphide and its Application to Production Engineering," H. Peter Jost, 7 p.m.

Thurs., March 19.—N. IRELAND REGION: Kensington Hotel, College Square East, Belfast, Annual General Meeting, 7.30 p.m. ★ SCOTTISH REGION: Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, C.2, "Recent Developments in Sintered Oxide Cutting Tools," R. N. Cook, 7.30 p.m. ★ SOUTH EASTERN REGION: Royal Empire Society, Northumberland Avenue, London, W.C.2, Annual General Meeting, "The Diploma of Technology and the Place of Human Studies in its Syllabus," A. C. Leyton, 7 p.m. ★ SOUTHERN REGION: Great Western Hotel, Reading, "British Aircraft Production Methods," L. G. Burnard, 7.30 p.m.

Fri., March 20.—WALES REGION: S. Wales Institute of Engineers, Park Place, Cardiff, Annual General Meeting, 7 p.m.; "Engineering Ceramics," C. G. Martin, 7.30 p.m.

INSTITUTION OF STRUCTURAL ENGINEERS

To-day, March 13.—MIDLAND COUNTIES BRANCH (GRADUATES' AND STUDENTS' SECTION): Birmingham Exchange and Engineering Centre, Stephenson Place, Birmingham, "Light Alloys in Structural Work," R. M. Davies, 6.30 p.m.

Tues., March 17.—LONDON GRADUATES' AND STUDENTS' SECTION: 11, Upper Belgrave Street, London, S.W.1, "Theoretical and Practical Aspects of Structural Steel Design," G. B. Godfrey, 6.30 p.m. ★ N. COUNTIES BRANCH: Cleveland Scientific and Technical Institution, Middlesbrough, "Extensions to Constructional Shop, 170ft and other Long Spans," F. R. Bullens, 6.30 p.m.

Wed., March 18.—YORKSHIRE BRANCH: The University, Leeds, "Prestressed and Reinforced Concrete Reconstruction in U.S.S.R.," V. V. Mickhailov, 6.30 p.m.

JUNIOR INSTITUTION OF ENGINEERS

To-day, March 13.—Pepys House, 14, Rochester Row, Westminster, London, S.W.1, "Ninety Million Gallons Per Day," 7 p.m.

MANCHESTER ASSOCIATION OF ENGINEERS

Fri., March 20.—Engineers' Club, Albert Square, Manchester, Annual General Meeting, "Production Investigations Applied in Practice," N. Dudley and F. Koenigsberger, 6.45 p.m.

PLASTICS INSTITUTE

Fri., March 20.—MIDLANDS SECTION: James Watt Memorial Institute, Great Charles Street, Birmingham, "Plastics in the Motor Industry," F. C. Watkins, 6.30 p.m.

REINFORCED CONCRETE ASSOCIATION

Wed., March 18.—11, Upper Belgrave Street, London, S.W.1, "The Use of Lightweight Concrete for Reinforced Concrete Structures," A. Short, 6 p.m.

ROYAL SOCIETY OF ARTS

Wed., March 18.—John Adam Street, Adelphi, London, W.C.2, "River Pollution: an Experiment in the Thames Estuary," B. A. Southgate, 2.30 p.m.

SHEFFIELD SOCIETY OF ENGINEERS AND METALLURGISTS

Mon., March 16.—University Building, St. George's Square, Sheffield, "The Conversion of a High-Lift Blooming Mill to a Universal Slabbing Mill," C. E. H. Morris and R. N. Dale, 7.30 p.m.

SOCIETY OF CHEMICAL INDUSTRY

Wed., March 18.—CORROSION GROUP: 14, Belgrave Square, London, S.W.1, "Economic Aspects of Corrosion," A. Keynes, 6.30 p.m.

Thurs., March 19.—ROAD AND BUILDING MATERIALS GROUP: 14, Belgrave Square, London, S.W.1, "Slag for Roadmaking," D. A. Dowdeswell, 6 p.m.

SOCIETY OF INSTRUMENT TECHNOLOGY

To-day, March 13.—MIDLAND SECTION: Regent House, St. Philip's Place, Colmore Row, Birmingham, 3, "Valves, Electrically and Pneumatically Operated," L. B. Rothwell, 7 p.m.

WEST OF SCOTLAND IRON AND STEEL INSTITUTE

To-day, March 13.—39, Elmbank Crescent, Glasgow, Joint Meeting with the Iron and Steel Institute, Engineers' Group, "The Installation and Commissioning of an 80-ton Electric Arc Melting Furnace," P. M. Thomas and A. MacNaughton, 6.45 p.m.

WOMEN'S ENGINEERING SOCIETY

Thurs., March 19.—LONDON BRANCH: Hope House, 45, Great Peter Street, Westminster, London, S.W.1, "Design and Use of Textile Finishing Machinery," H. Ellis and J. H. Hilton 7 p.m.

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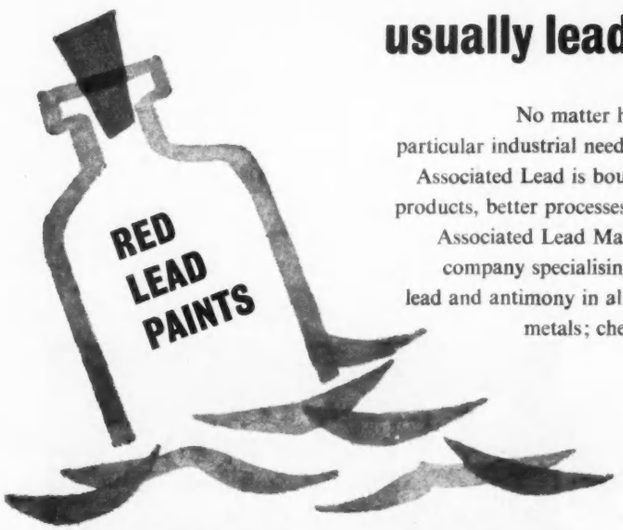

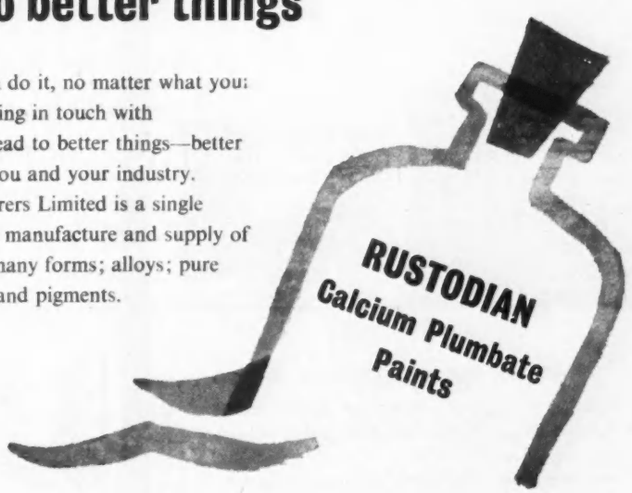

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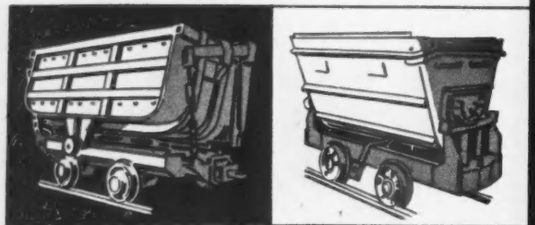

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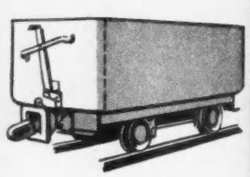

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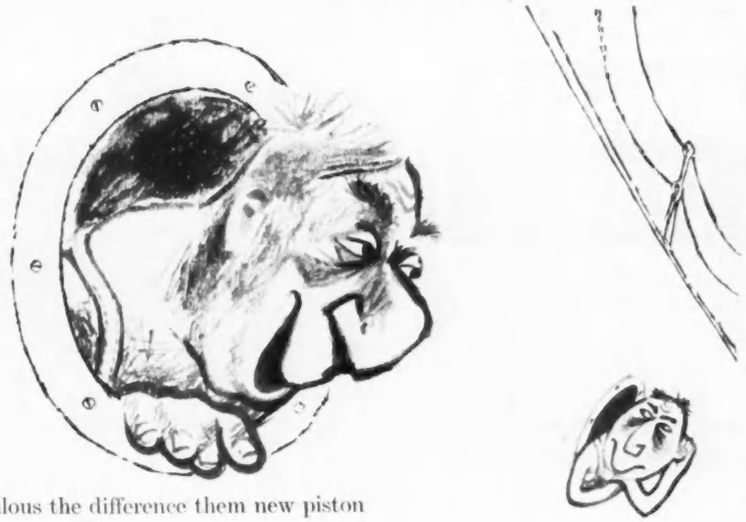

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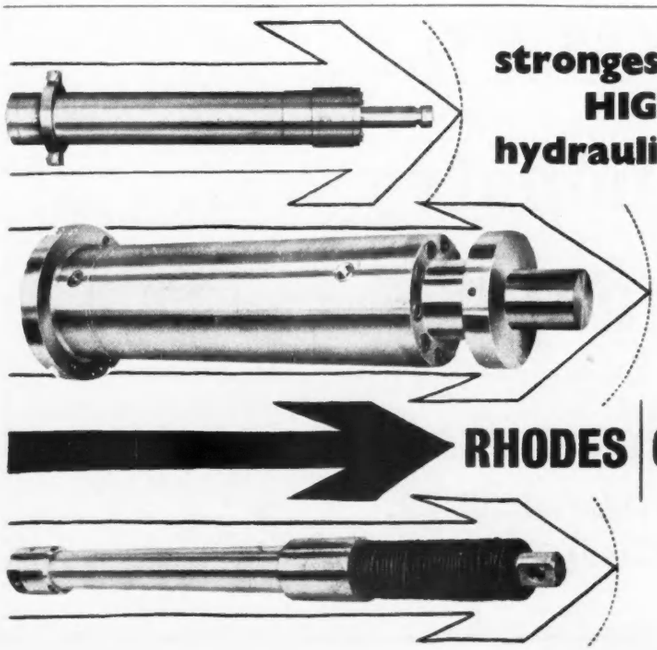

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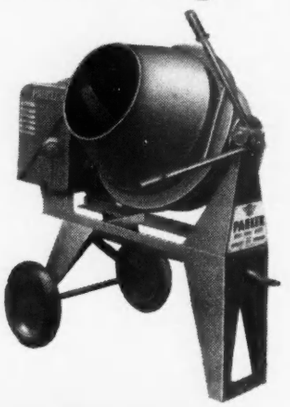

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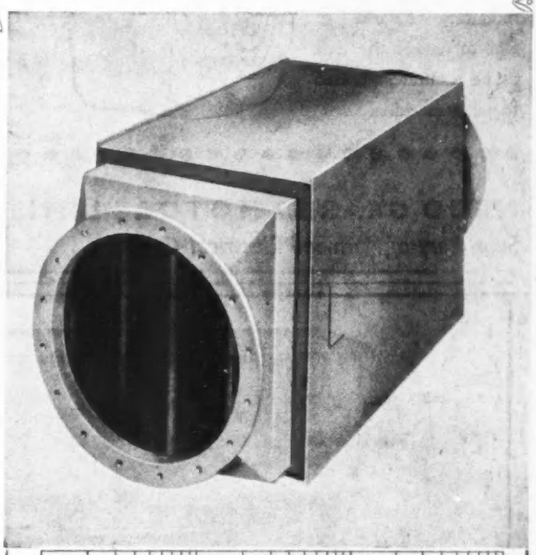

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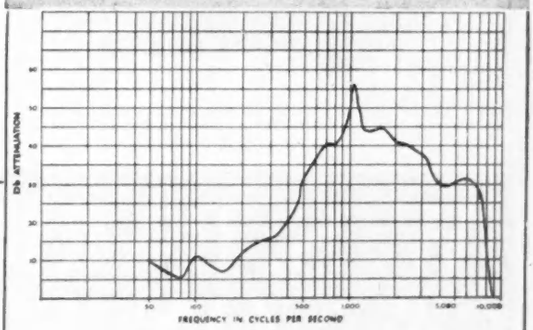

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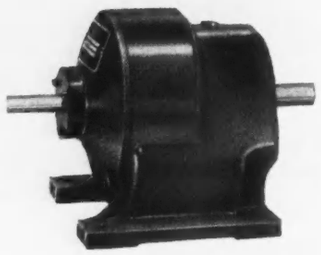

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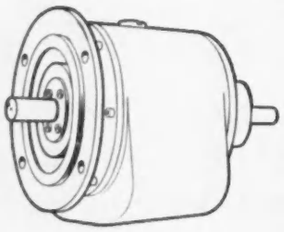

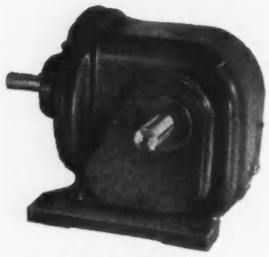

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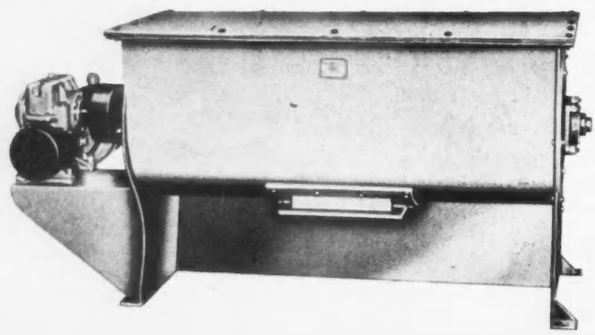

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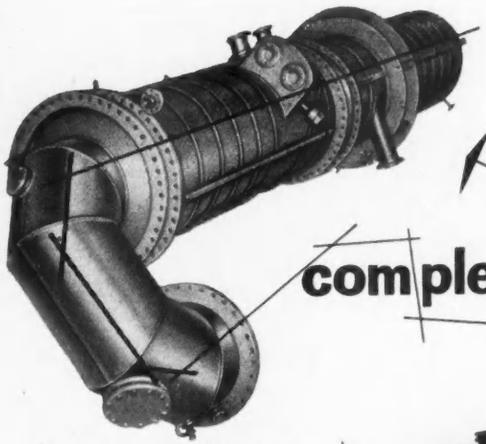

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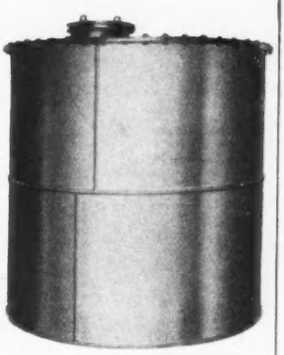

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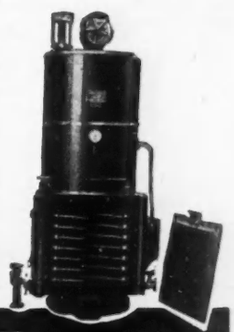

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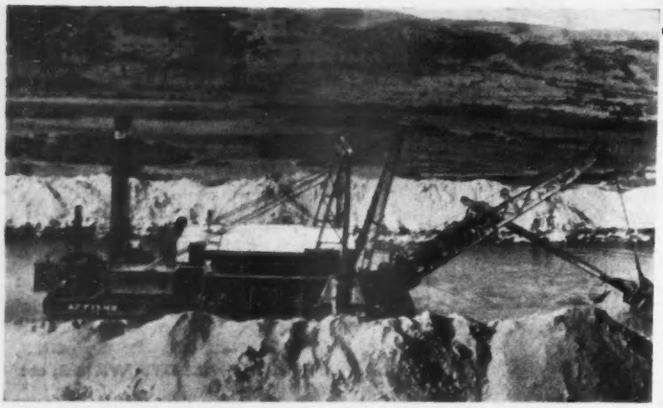

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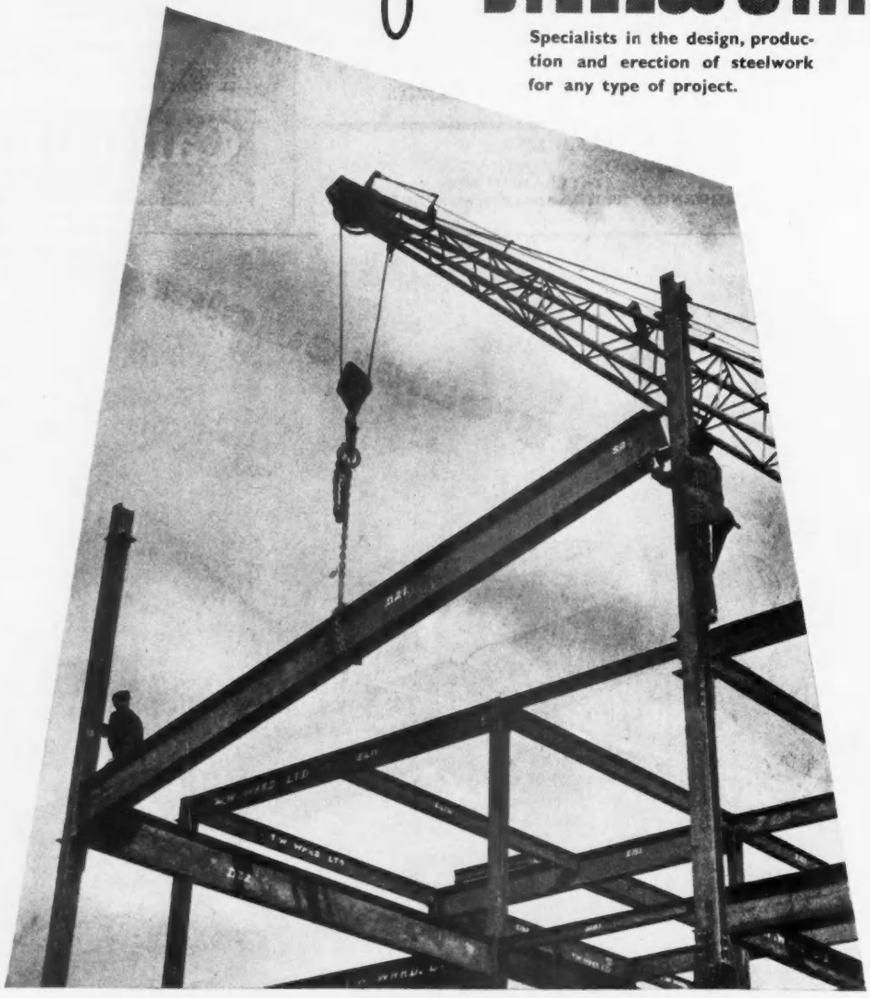

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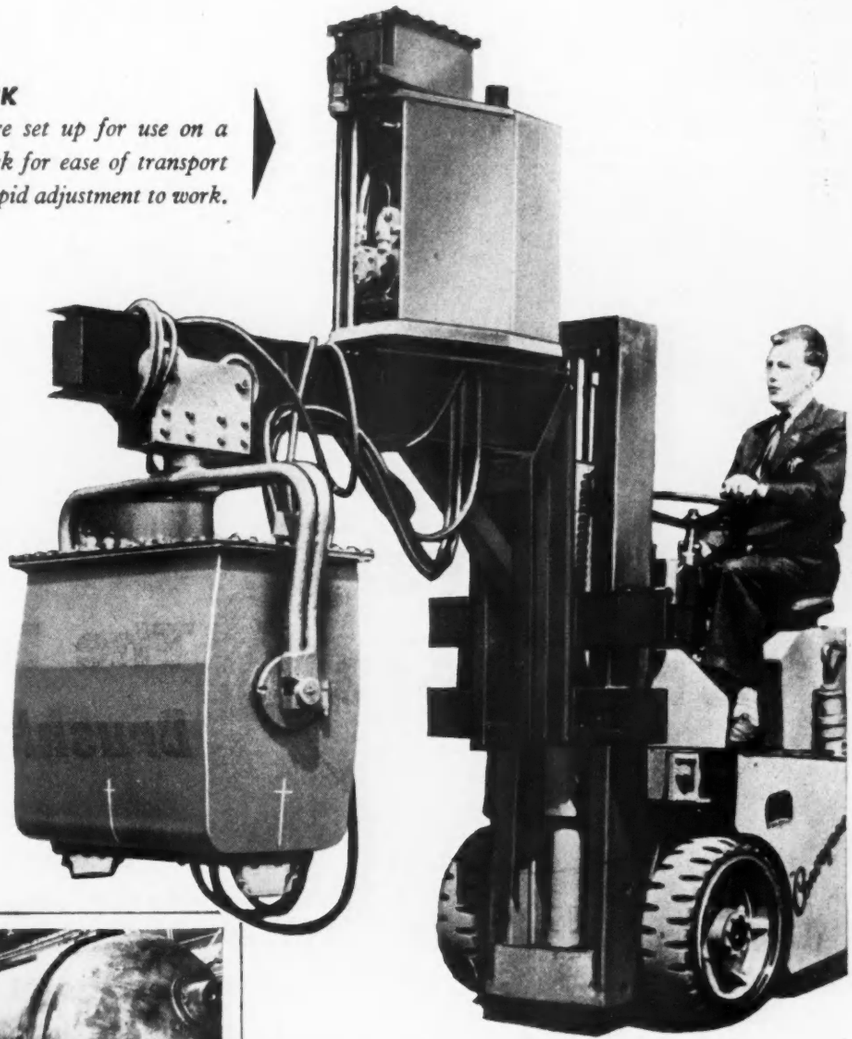

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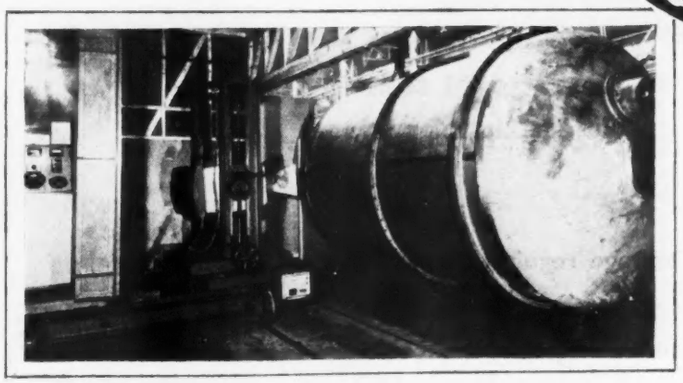

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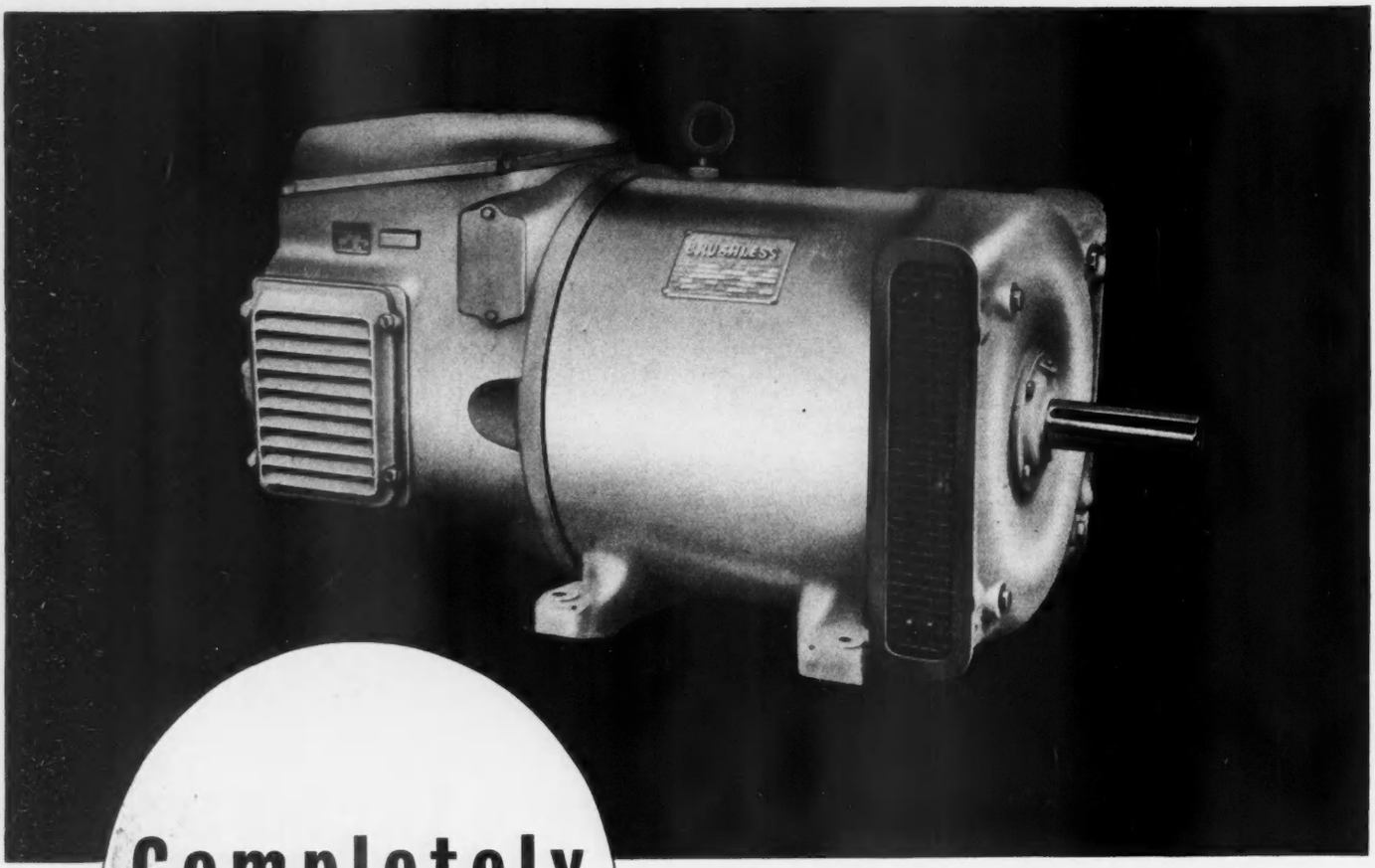

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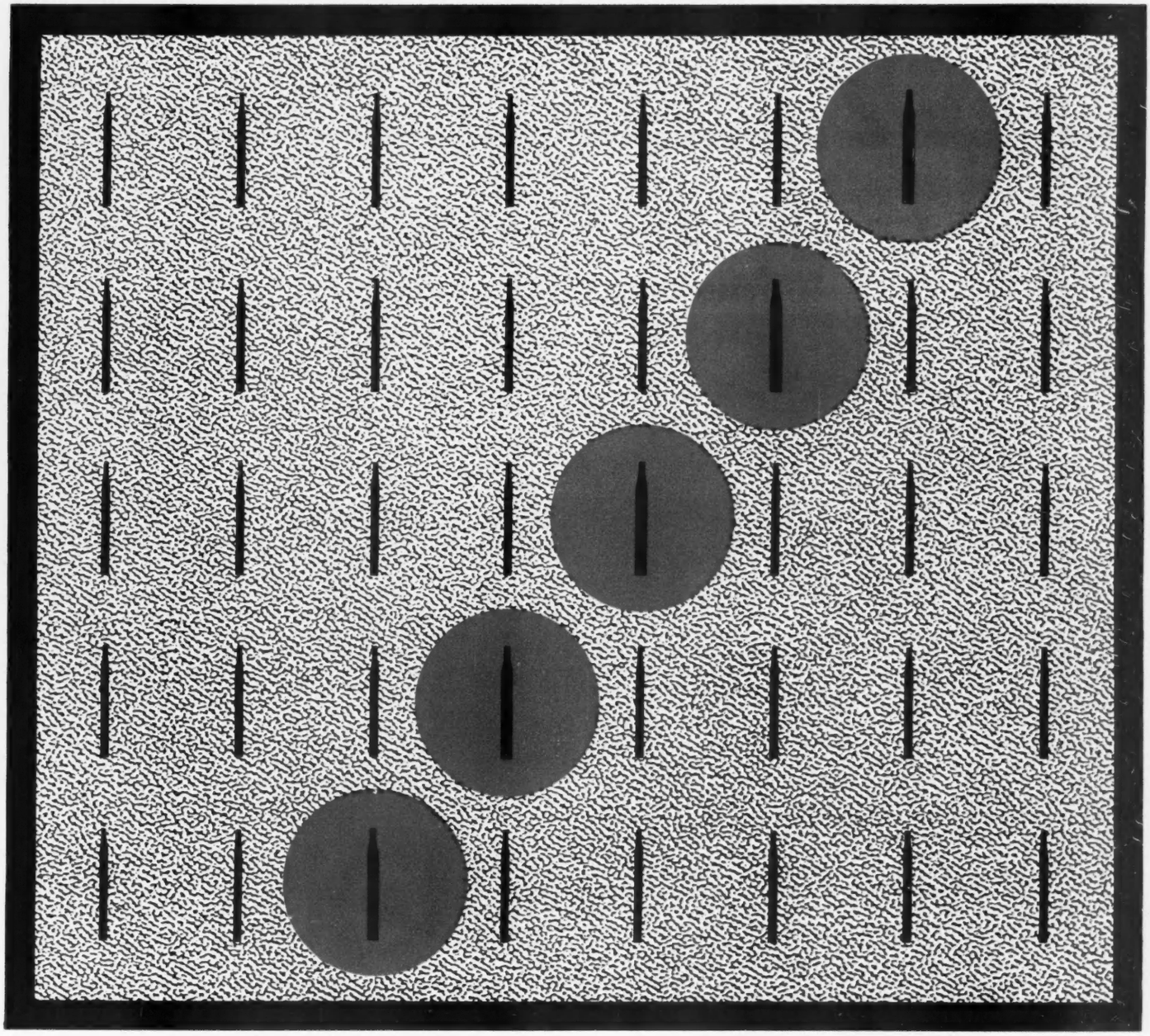

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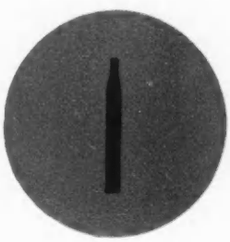

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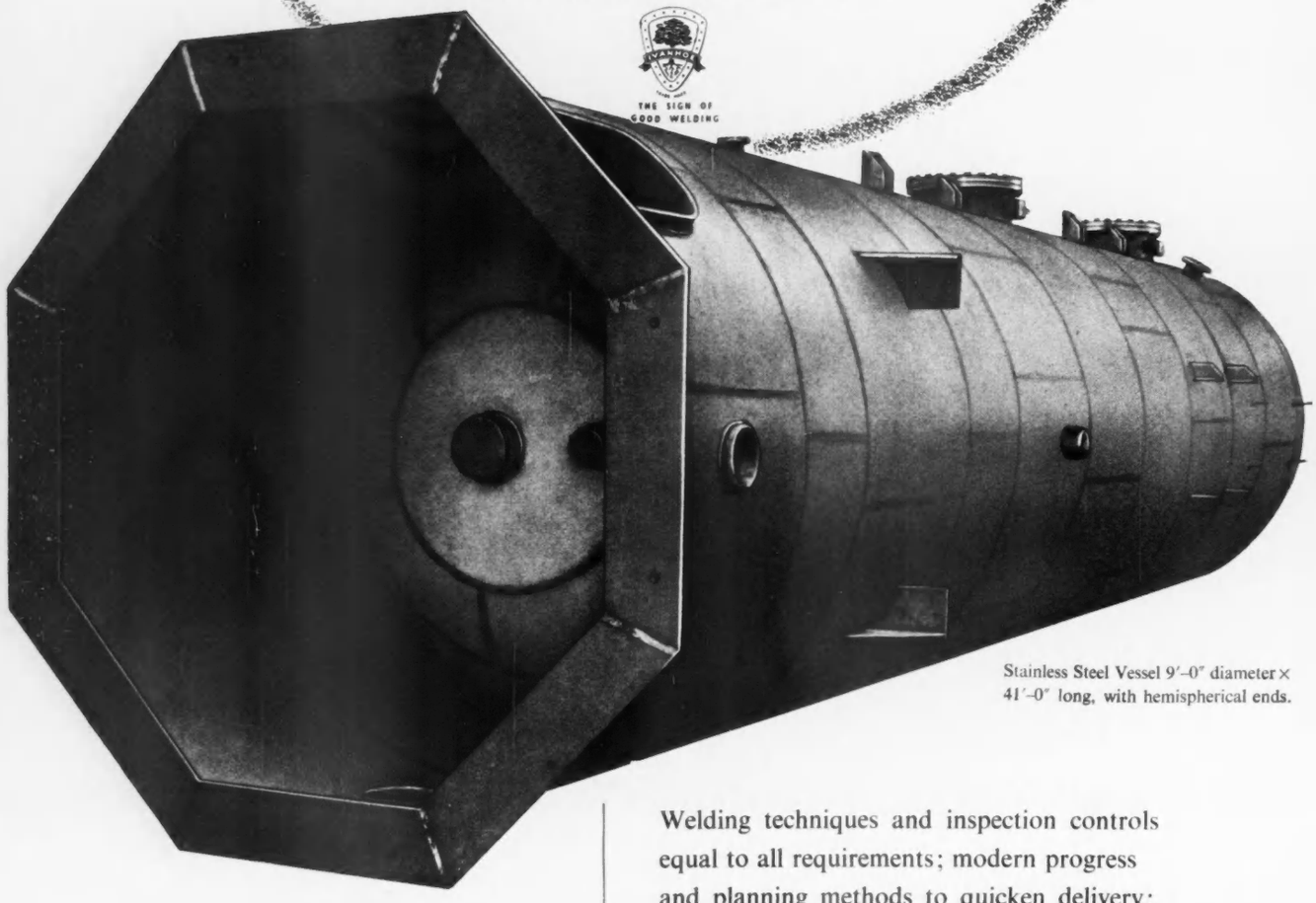

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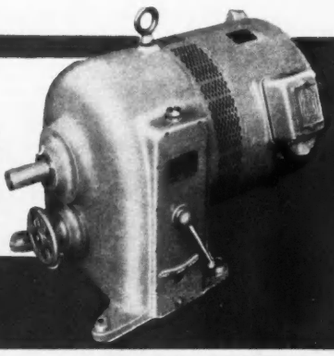

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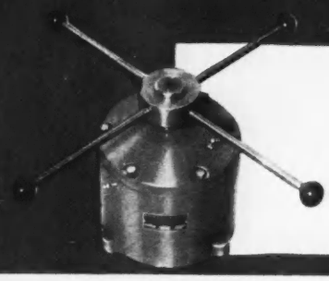

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Co-axial shafts. Flange mounting. Developed for individual applications. Hand or power operation.

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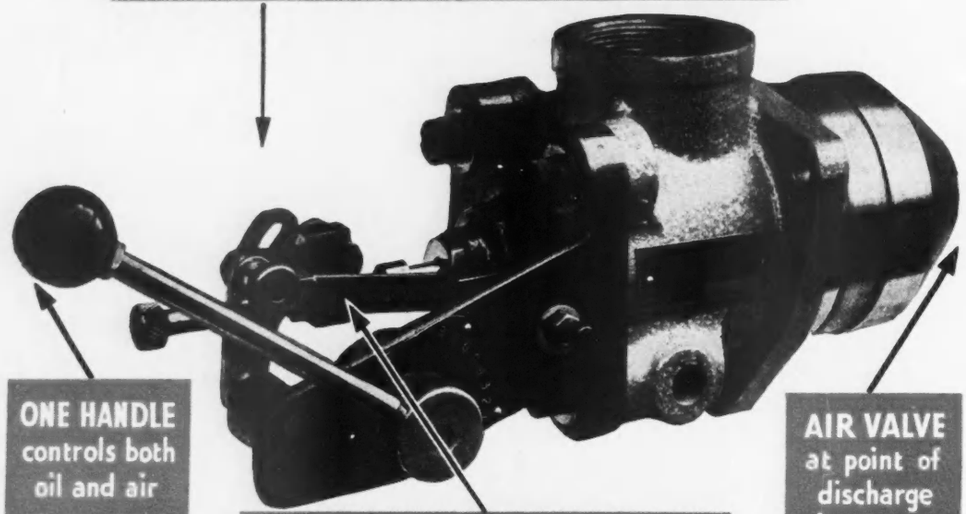
The FIRST Self Proportioning OIL BURNER Made in Gt. Britain ★



ONE HANDLE controls both oil and air at constant proportion

NOW made with OIL VALVE STROKE infinitely variable by two adjustments only

AIR VALVE at point of discharge gives a 5:1 turn down ratio

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Schieldrop Industrial Burners cover a wide range of types to suit all normal needs. Designs gladly submitted for any type of Burner to special requirements. Schieldrop Burners save tons of fuel, and quickly prove to be a most profitable investment and a highly efficient productive unit. Send for full details of operating results, and catalogues quoting reference A/12.

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constant tension supports

FOR LOADS UP TO 8 TONS
PIPE MOVEMENTS UP TO 18″

High-pressure steam piping is subject to wide variations in temperature, which produce considerable expansion and contraction. Unless the pipe supports can absorb and compensate for this movement, severe stresses are set up which may result in fracture. The " Con-Ten " Pipe Support is designed to cradle any type of piping with constant tension under all conditions, throughout the range of movement. " Con-Ten " is installed, with eminently satisfactory results, in power stations, oil refineries, chemical and industrial plants throughout the world.

British Patent Nos. 474008 720074 720075 697987 657318
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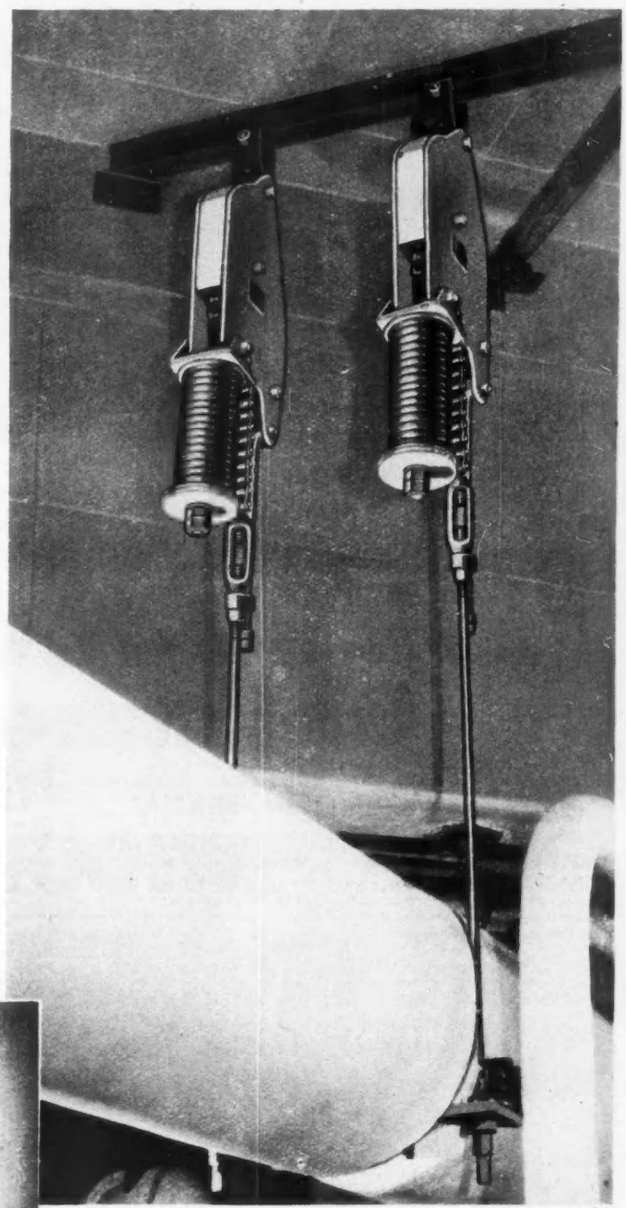
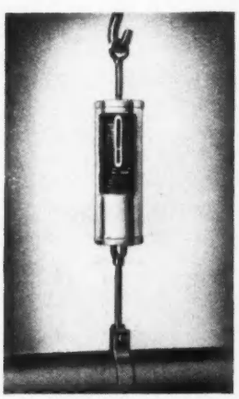
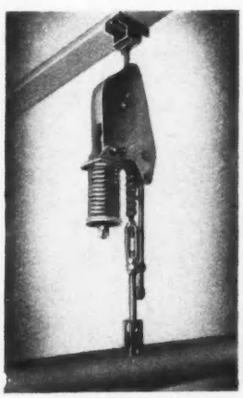


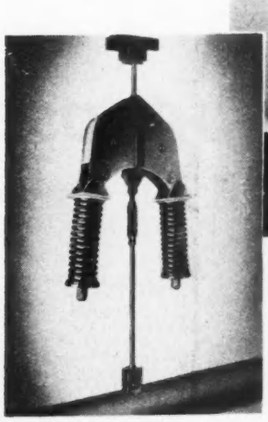
Ferrybridge " B " Power Station, Central Electricity Generating Board, Yorkshire Division. H.P. Steam pipes supplied and installed by Stewarts and Lloyds, Ltd.



Leibfried Red Top Pipe Supports for load from 100 to 5,000 lbs. and total travel of 3″.

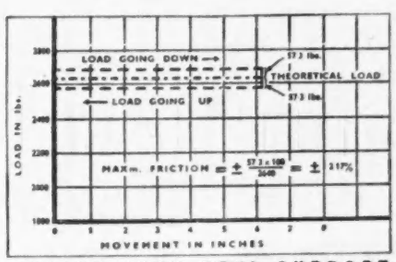


Conventional type " Con-Ten" Supports for loads of up to 2 tons with a total vertical movement up to 12″.



Duplex " Con-Ten " Supports for load of up to 8 tons with a total vertical movement up to 12″. This type is acknowledged as one which produces minimum friction and kinematic variation. It has been specially designed for any applications where exceptional accuracy is demanded.

From graph it can be seen that the maximum friction is equivalent to 2.17% of the applied load.



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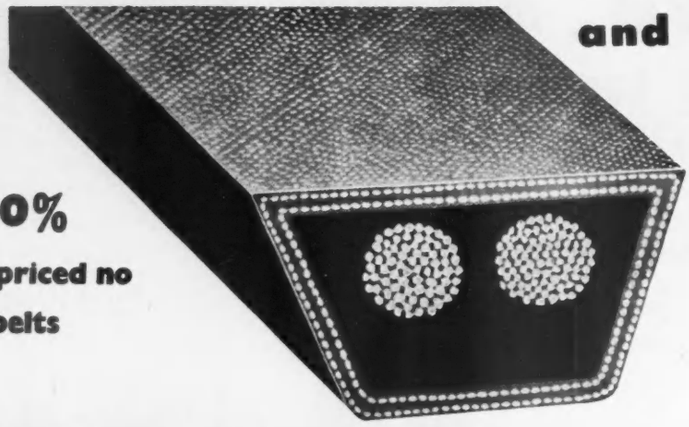

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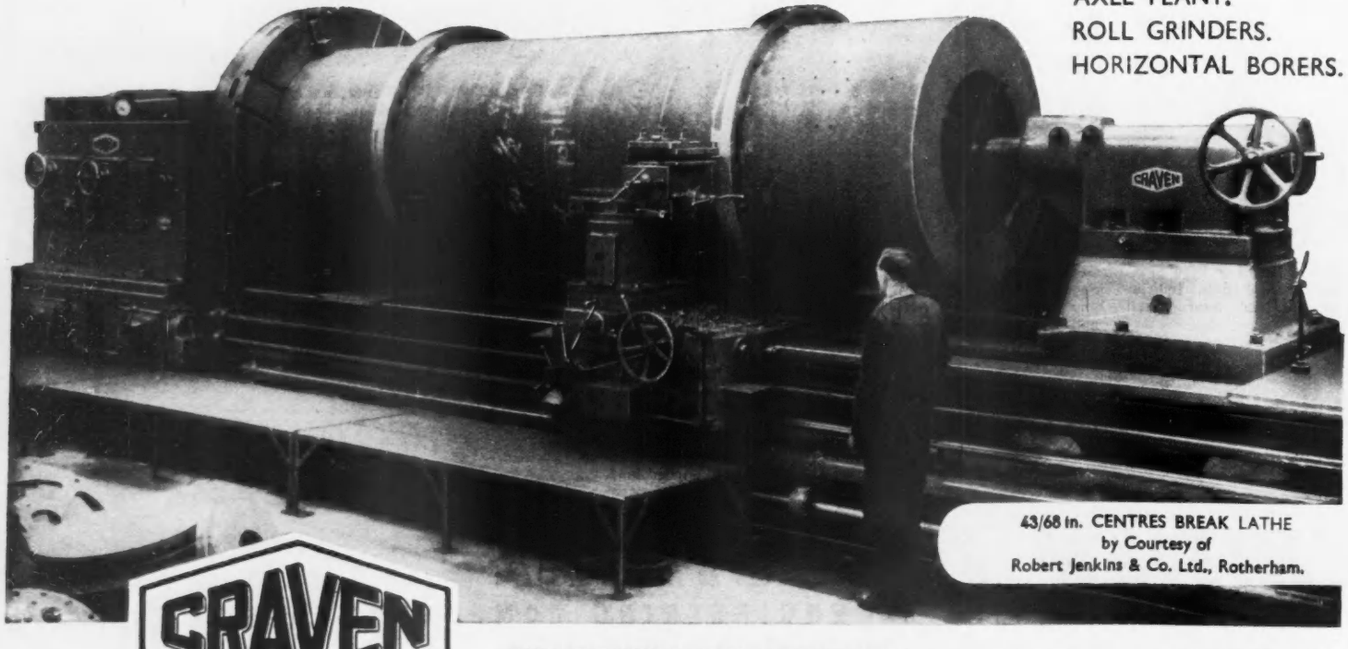

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by Courtesy of
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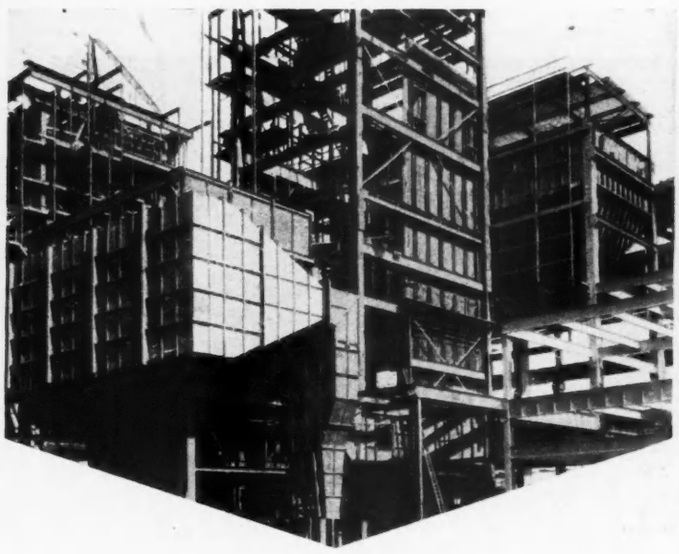

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CONSTRUCTION AT

LITTLE BARFORD 'B'

by

FOSTER WHEELER

for the

CENTRAL
ELECTRICITY
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Illustration shows outdoor installation of 2 P.F. boilers at Little Barford "B" Power Station. Each boiler 550,000 lb/hr; 950 psig; 925° F.

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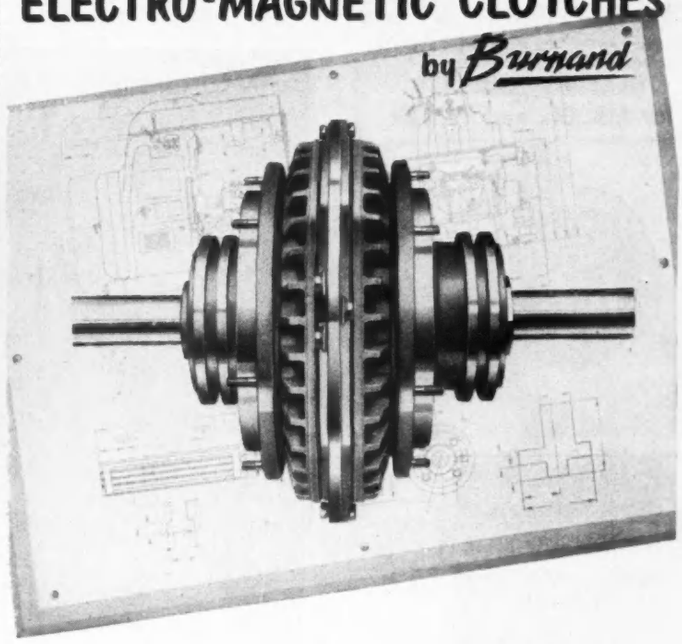

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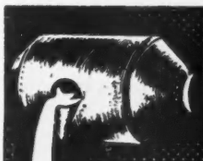

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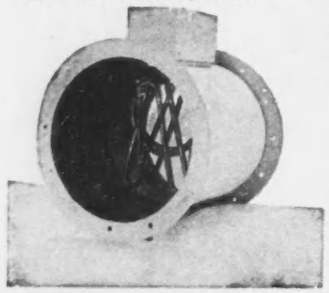

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FRICTION GRIP BOLTS

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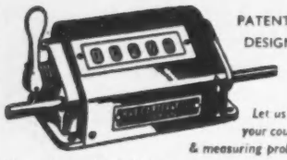

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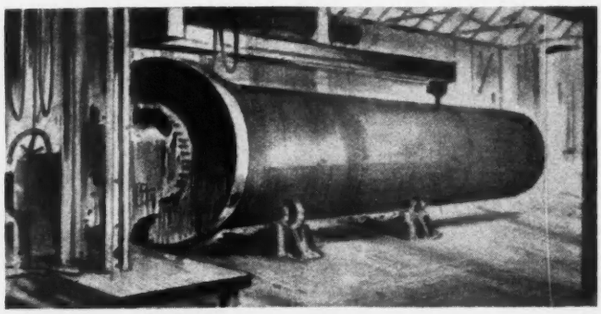
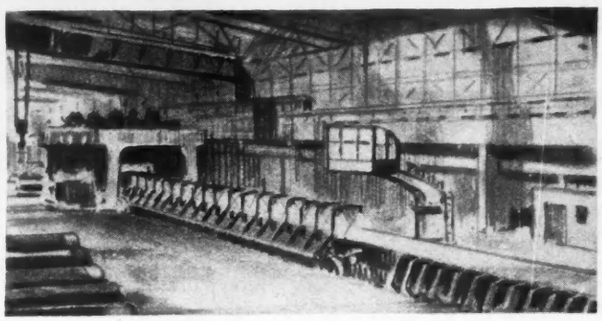
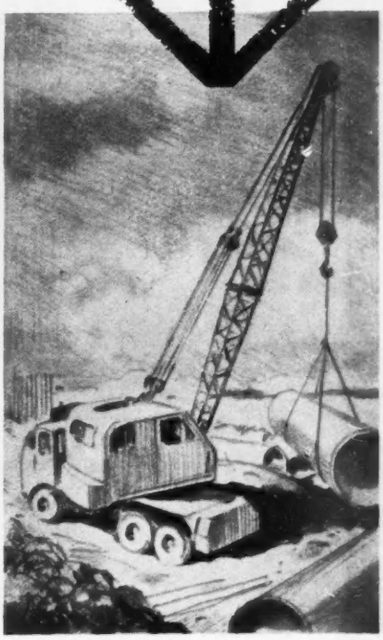






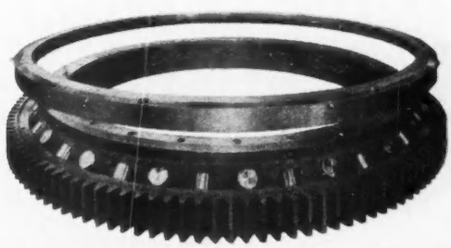
*turn to the Cross-Roll Bearing

Evolved, perfected and manufactured in Great Britain in collaboration with British Timken Limited.

The Priestman Cross-Roll Bearing consists of four separately machined rings. When bolted together in pairs the roller paths form a diamond pattern race section.

The Timken tapered rollers, spaced on the pitch circle by pressed steel cages, alternately contact opposing race surfaces of the outer and inner rings. The crossing of the roller axes in combination with the inclination of the roller paths is the feature that enables the Bearing to resist loads in all directions.

Priestman Cross-Roll Bearings are pre-loaded, pre-lubricated, and sealed self-locating assemblies, requiring no adjustment and little maintenance beyond the periodical replenishment of grease in the labyrinth which supplements the special synthetic rubber cruciform seal, excluding all foreign matter.



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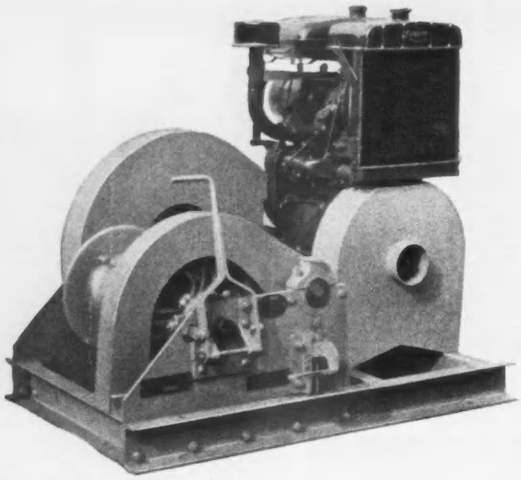
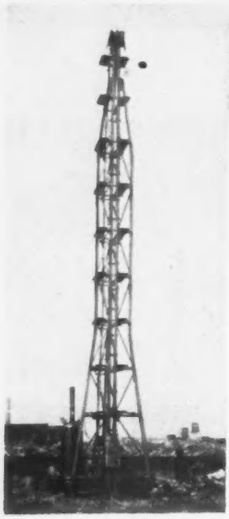


Winches

with lifting capacities up to 15 tons, and capable of working pile driving hammers up to 8 tons. Driven by petrol or diesel engines, electric motors or steam.



Pile Drivers

in a standard range of extensible pile frames, in four sizes, providing heights from 20 ft to 90 ft high, using monkeys from 1 ton to 4 tons. Special frames for hammers up to 6 tons.

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Jetwell dewatering equipment, including jetting pumps, dewatering pumps, wellpoints and all necessary pipes and fittings.

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Portable diaphragm pumps, double acting ram pumps, centrifugal pumps and self-priming centrifugal pumps, using petrol or diesel engines or electric motors. Univac pumps, test pumps, and vertical self-priming sinking pumps.

Lifting Tackle

including crab winches, shear legs, pulley blocks, chain blocks, swivel guide blocks, gin blocks, spring hooks, sling chains, jim crows, shackles, and jacks of all types.

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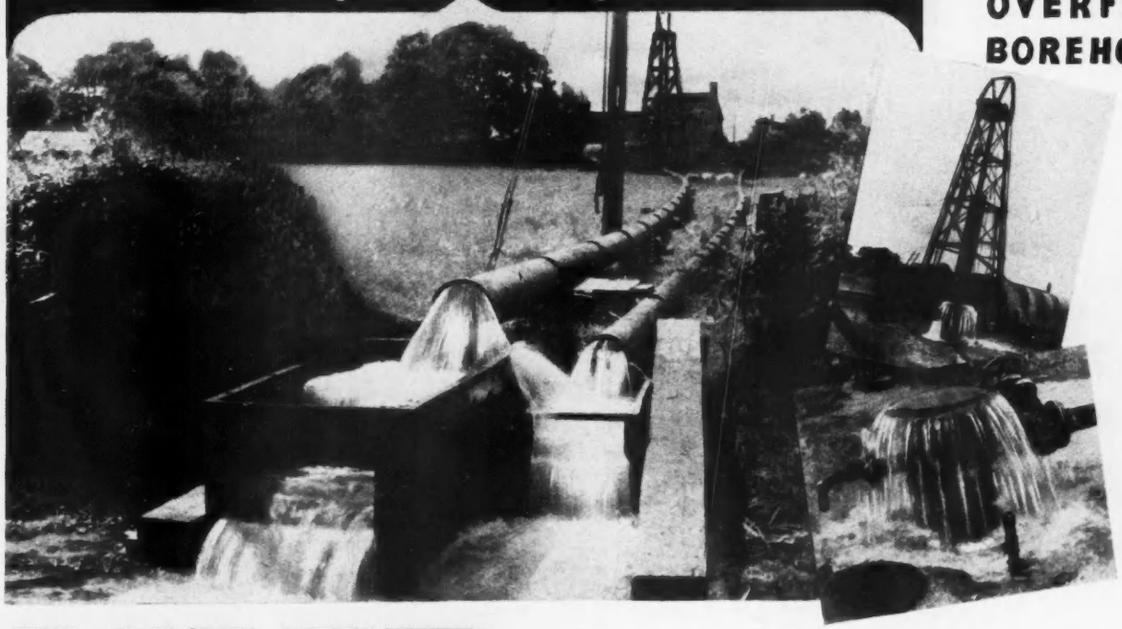
4 MILLION GALLONS per day

FROM THREE 30" DIAMETER OVERFLOWING BOREHOLES



For almost a century we have been constructing wells, and time has proved that they were well done.

It has always been our policy to give attention to detail and to visualise the end, with the intermediate snags, in order to bring the job to a successful conclusion.

Our knowledge of Water Engineering is old in years, but our outlook and approach are as new as tomorrow.

Let us tackle your Well job now and give you a well done job.

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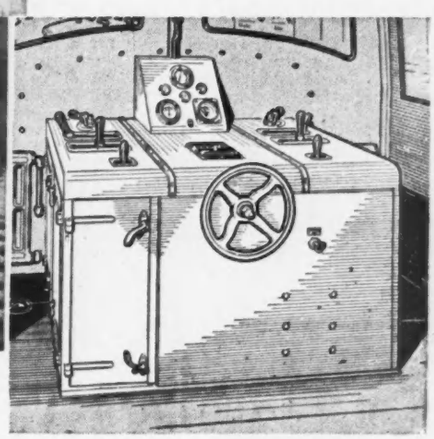
The controls of the Peckett Diesel Locomotive are easy to handle—no special manipulation of throttle or clutch is required for gear changing.



PECKETT *diesels*

The various control levers have been carefully grouped for maximum convenience and are duplicated on either side of the control desk. In conjunction with the extraordinary all-round vision from the fully-enclosed cab, this simplicity greatly minimizes fatigue and mental distraction, and ensures the fullest output from driver and locomotive.

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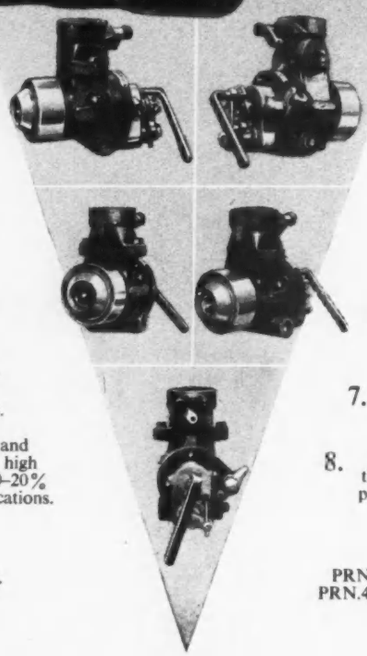
Nu-way presents ROTAVAC P.R.N. SERIES proportioning oil burners



Advantages

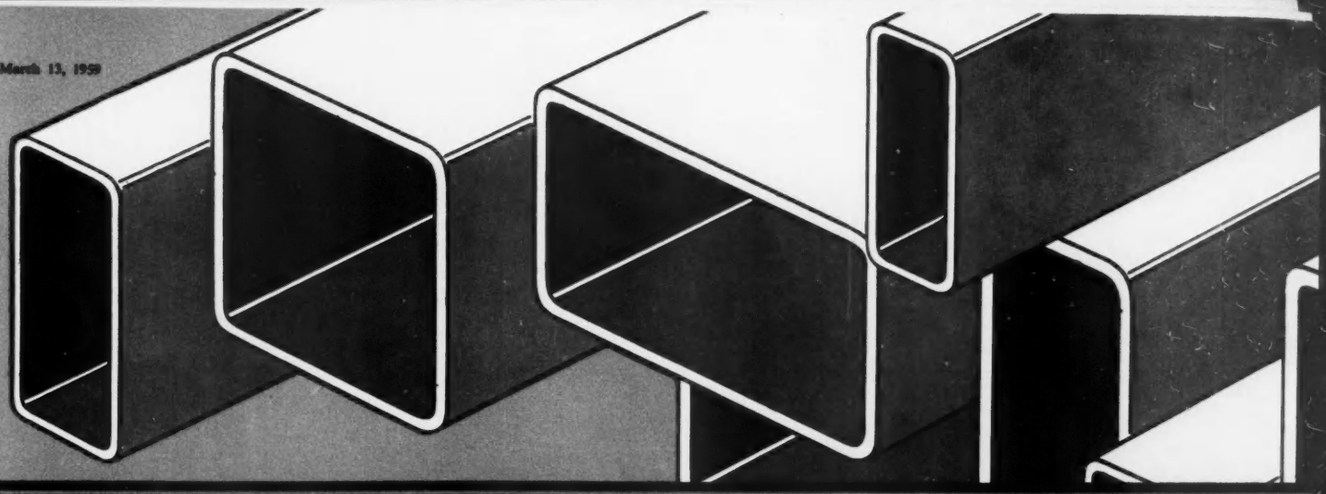
1. ONE LEVER controls both oil and air, keeping the ratio constant from maximum to minimum firing rate. Easily and efficiently operated by unskilled labour.
2. RADIAL MOVEMENT allows burner to be easily controlled in groups on one furnace instantly and accurately by shaft or cable. Manual or automatic control.
3. QUICK-RELEASE inner assembly makes nozzle cleaning a simple operation. Patent withdrawal latch overcomes sticky fuel oils.
4. ANY FURNACE ATMOSPHERE selected at will and maintained throughout firing range with uniformly high CO_2. Often gives reduced fuel consumption of 10–20% when replacing ordinary burners in particular applications.
5. VARIABLE AIR/OIL VALVE COUPLING allows selection of the correct air/oil ratio while the burner is running. Any ratio once selected remains constant from high to low flame. For extra-low flame see below.
6. EXTRA-LOW FLAME SHIELD provides reduced air pressure to give a smaller stable low flame for special applications.
7. REGULATING SLEEVE allows adjustment of flame shape while the burner is in operation.
8. ISOLATOR VALVE shuts off air supply when servicing the burner. An intermediate setting gives reduced air pressure for quicker, simpler lighting.

Models

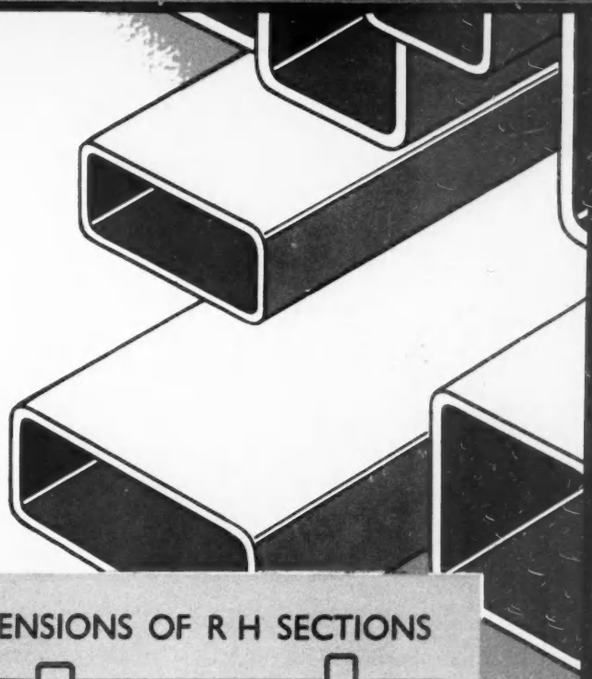
PRN.1 cap 3½ imp. gals./hr.
PRN.2 cap. 6 imp. gals./hr.
PRN.3 (available shortly).
PRN.4 cap. 30 imp. gals./hr.

Particulars from:

NU-WAY HEATING PLANTS LTD (Box A403) Droitwich
and at London, Manchester, Newcastle, Glasgow, Belfast, Dublin, Bristol



A further advance in tubular steelwork:



RECTANGULAR HOLLOW SECTIONS

Welded tubular construction has made great progress in recent years in its applications to mechanical handling and similar equipment. A further step forward is being made with our new range of hot-rolled Rectangular Hollow Sections. These have been developed in conjunction with our subsidiary, Tubewrights Ltd., who are acknowledged specialists in tubular construction.

SIMPLICITY

R.H. Sections eliminate the need for special shaping of component members prior to welding. Any straight cut R.H.S. or tube will fit accurately against their flat sides whether square-on or at an angle and, moreover, lugs of various kinds produced from tube or bar are easily attached. Welding is simple and no bevelling is necessary.

SIZES

16 standard sizes of hot-rolled R.H. Sections are available, each in two thicknesses; they range from 1⅜" square to 5" x 2⅛". Several sections have matching dimensions and this is of advantage in the production of neat fabricated structures. The 1⅞" square R.H.S., for example, matches the short sides of a 3⅝" by 1⅞" R.H.S.; these matching dimensions are made clear in our pamphlet, and in the accompanying table.

DIMENSIONS OF R H SECTIONS

INCHES	S.W.G	INCHES	S.W.G
1 x 1	12g, 10g	2½ x 1⅜	11g, 9g
1⅜ x 1⅜	11g, 10g	3⅛ x 1⅝	10g, 9g
1⅞ x 1⅞	11g, 9g	3⅝ x 1⅞	10g, 8g
2⅛ x 2⅛	10g, 9g	4¾ x 2⅜	9g, 7g
2⅜ x 2⅜	10g, 9g	1⅞ x 13/16	11g, 10g
2½ x 2½	10g, 8g	2¾ x 1	11g, 9g
2¾ x 2¾	10g, 8g	3⅜ x 1⅜	10g, 9g
3⅝ x 3⅝	9g, 7g	4 x 1⅝	10g, 8g
MATCHING DIMENSIONS ARE SHOWN IN HEAVY TYPE		5 x 2⅛	9g, 7g

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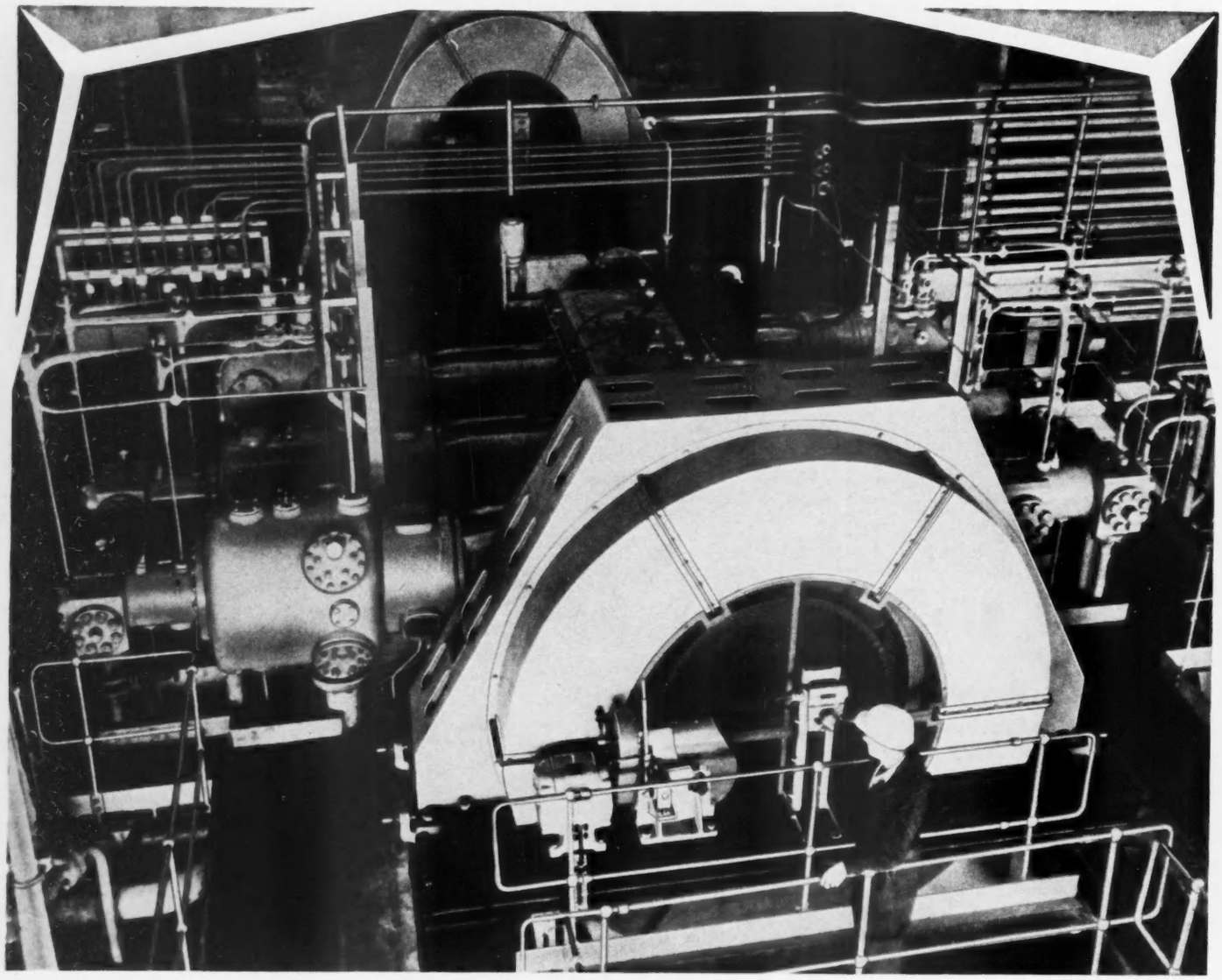

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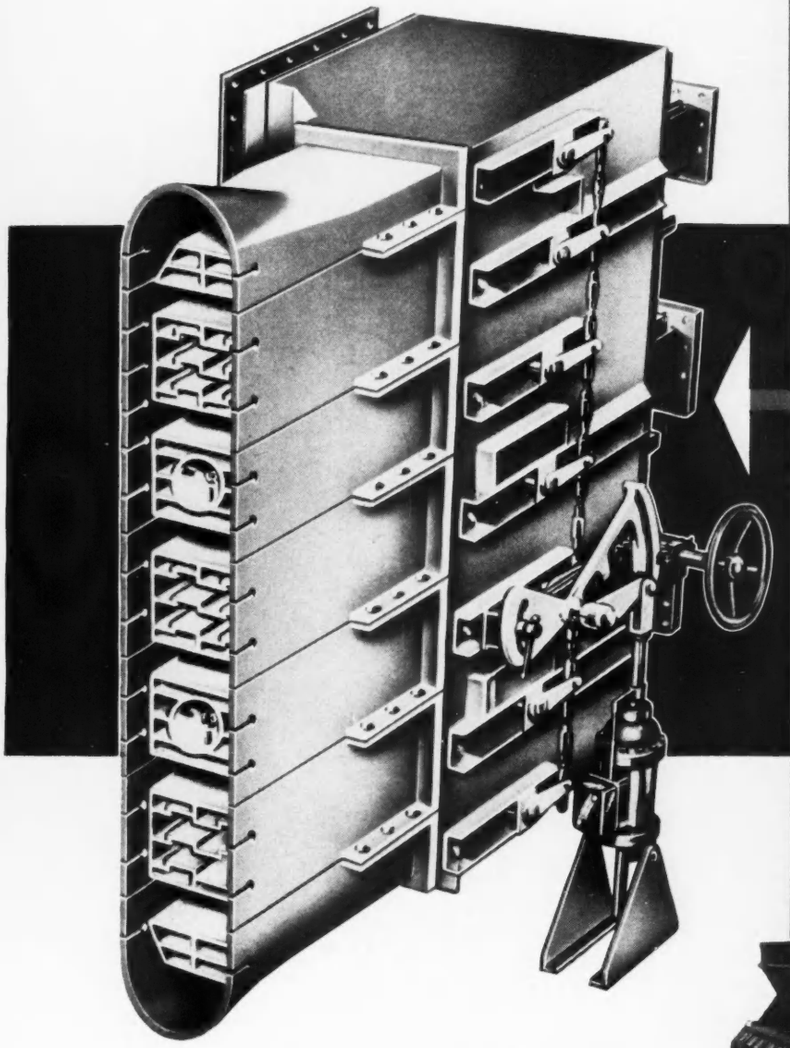

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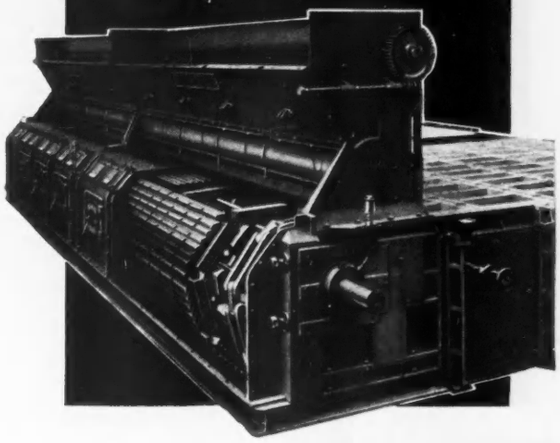

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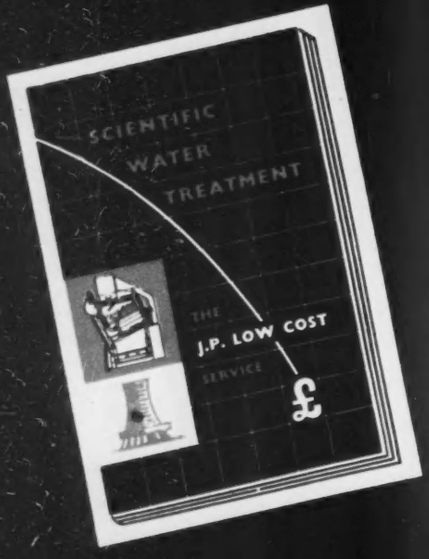

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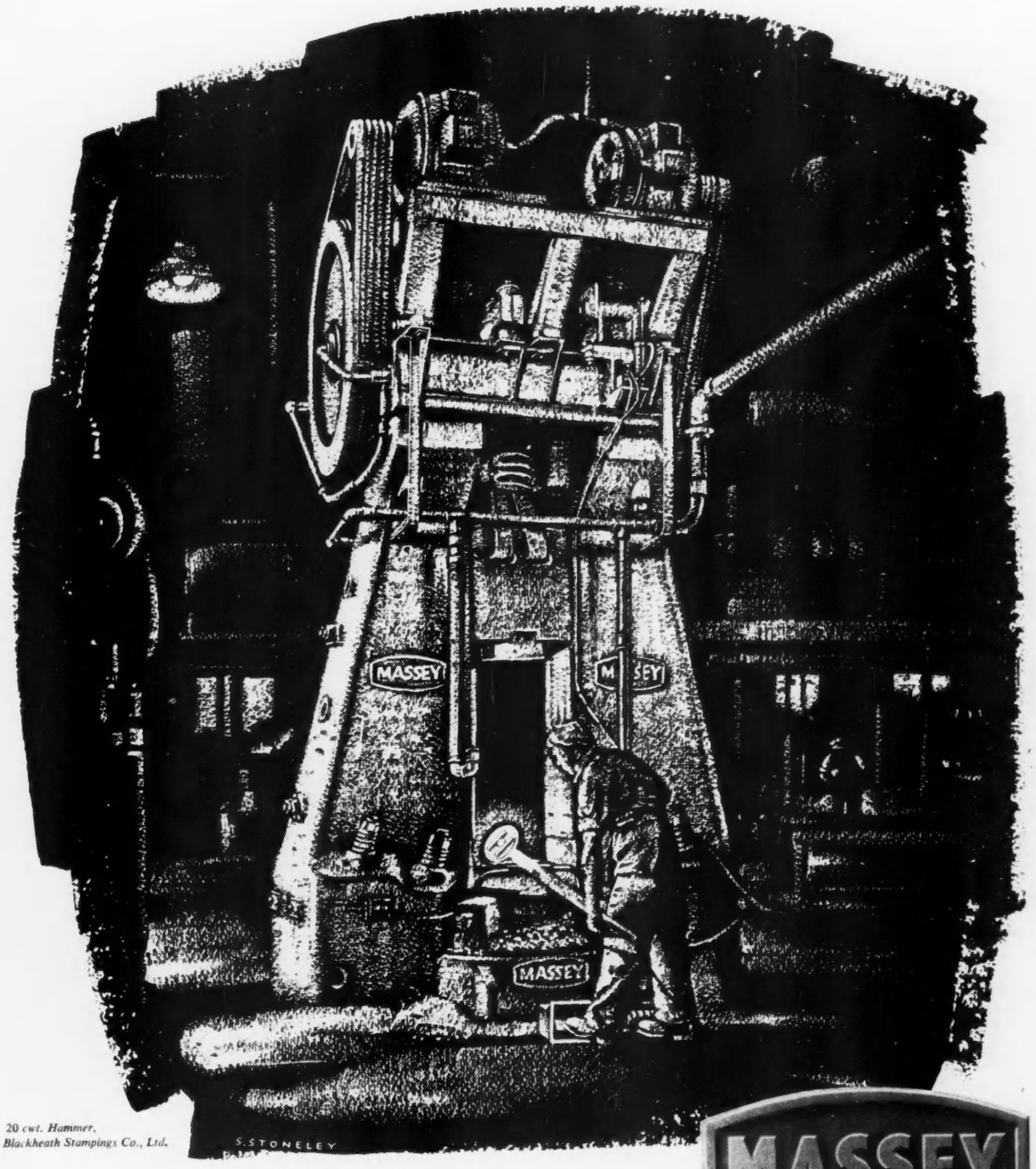

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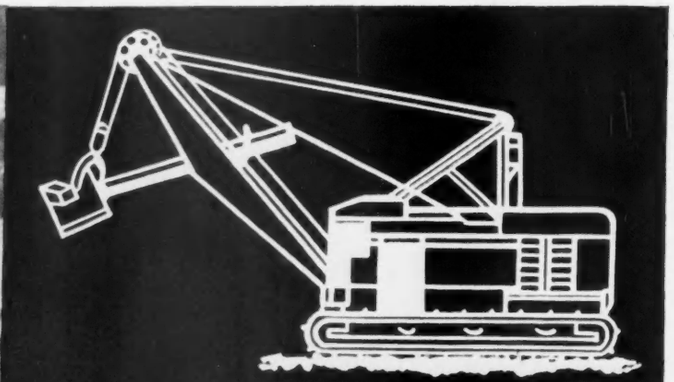

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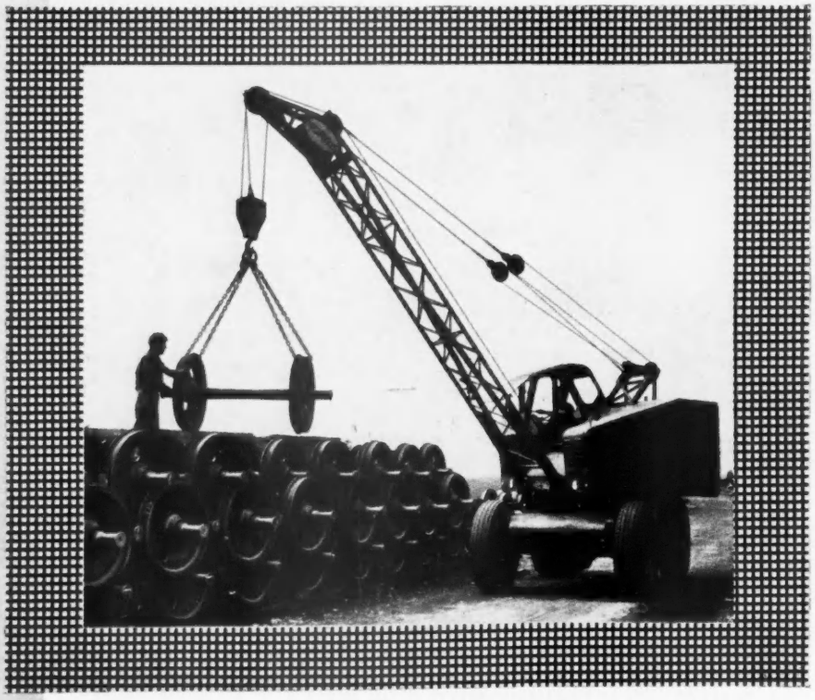

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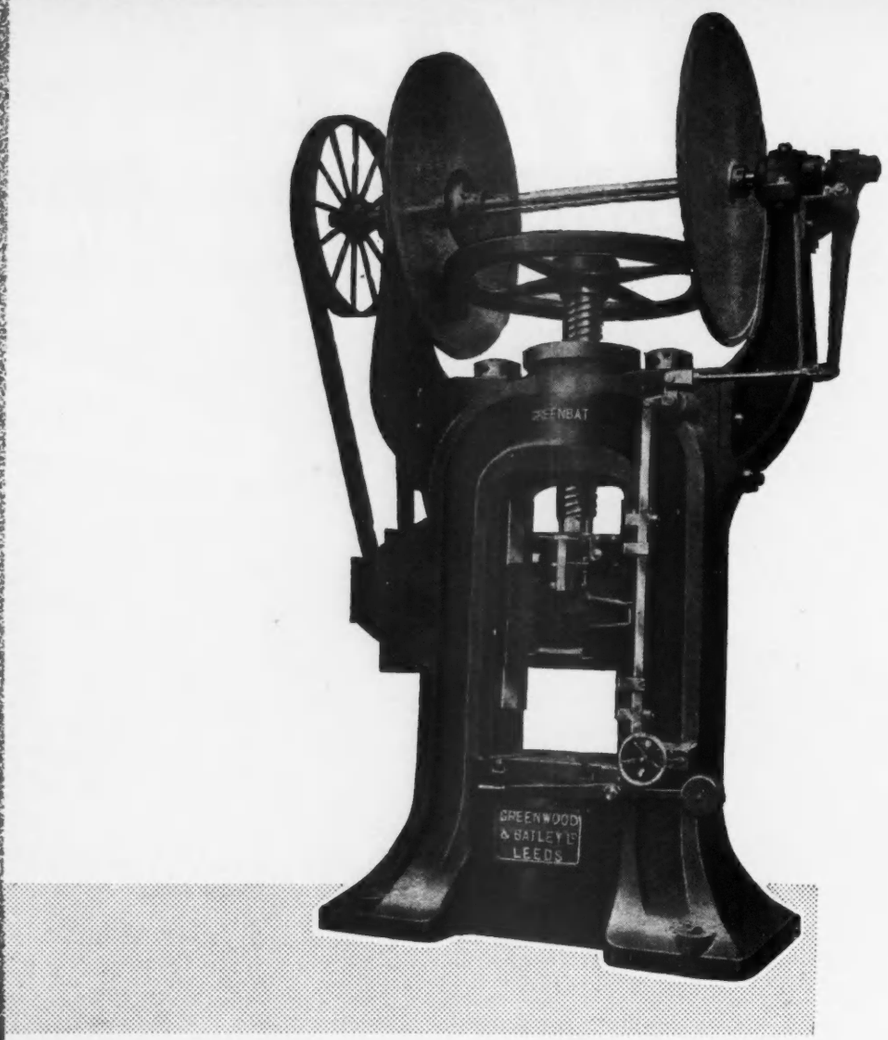

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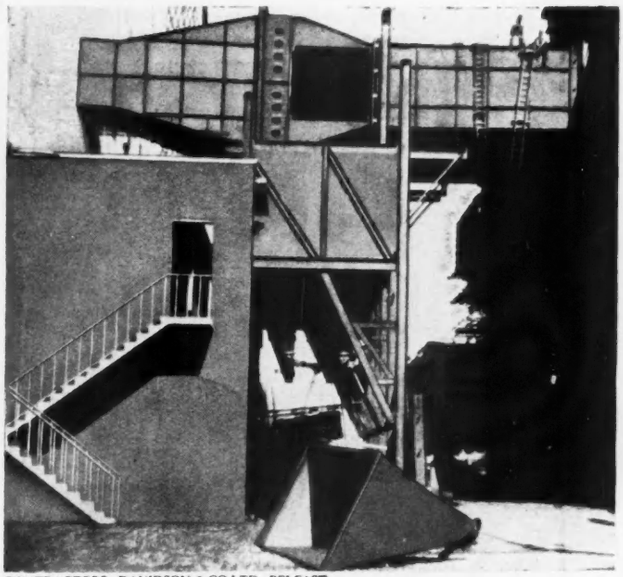

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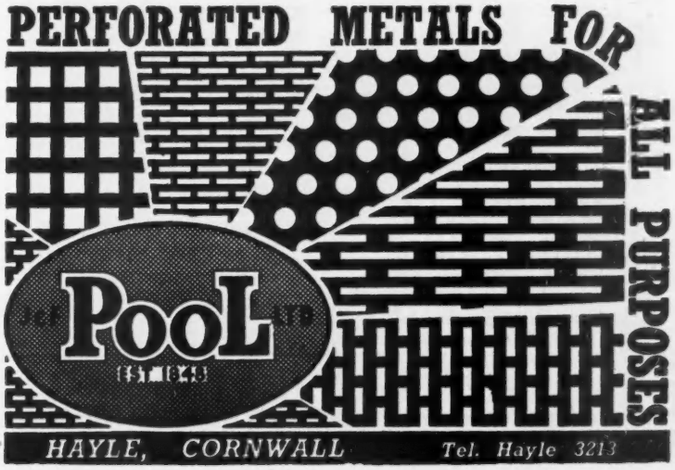

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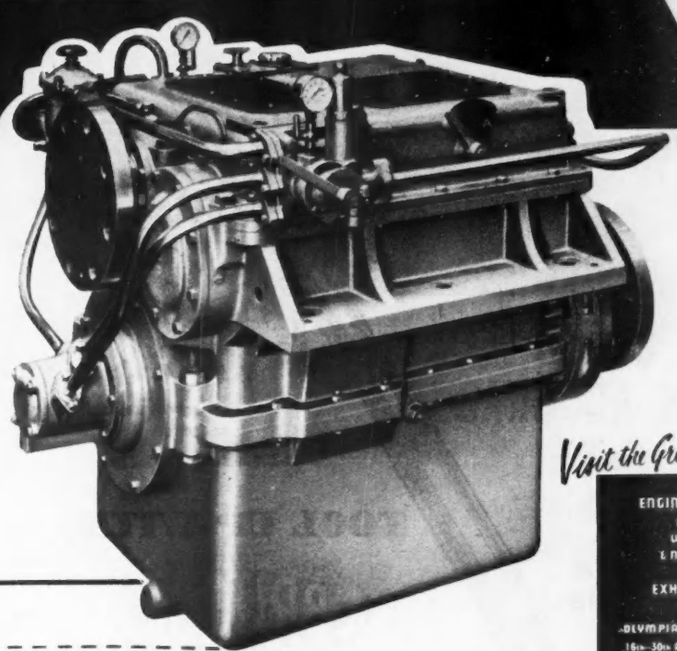

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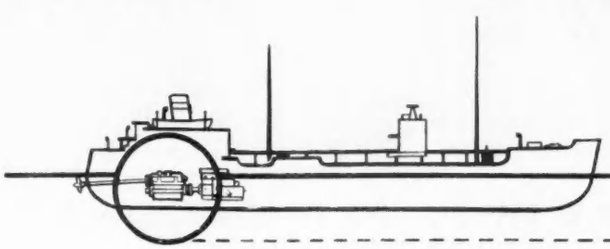

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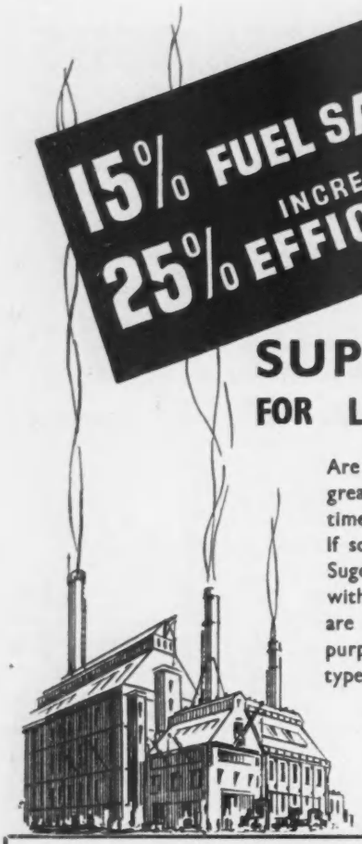

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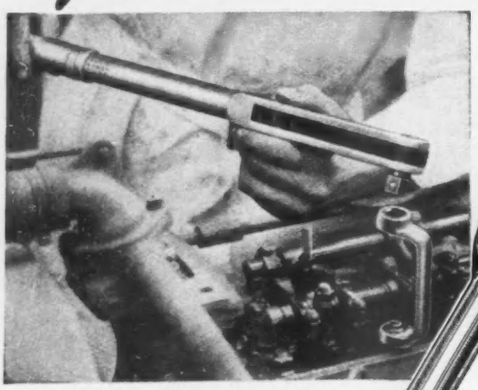

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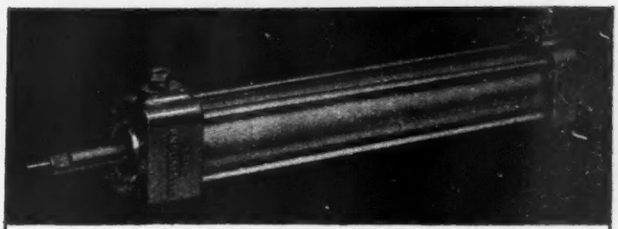

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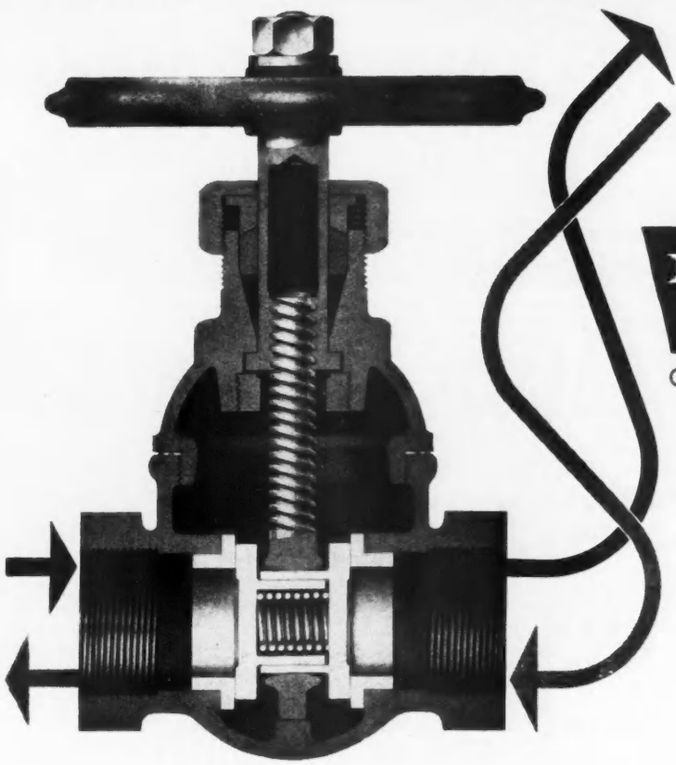

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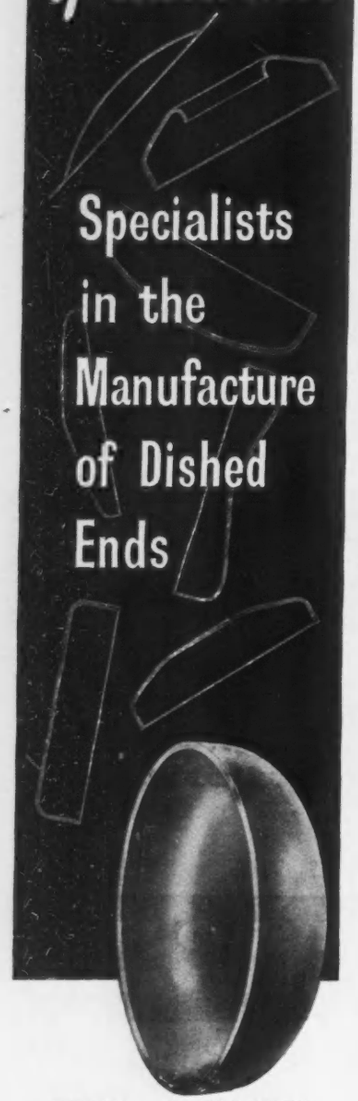

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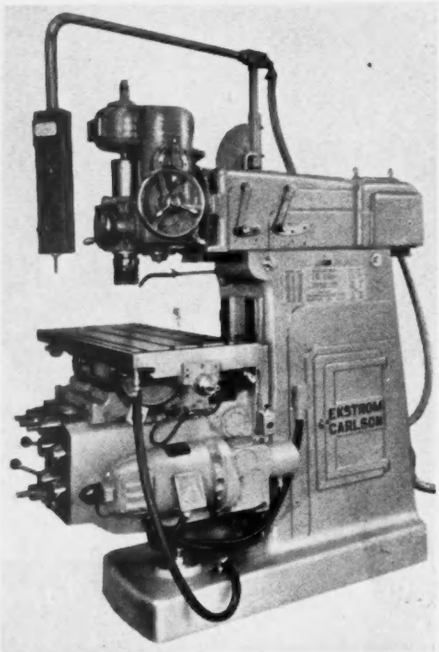

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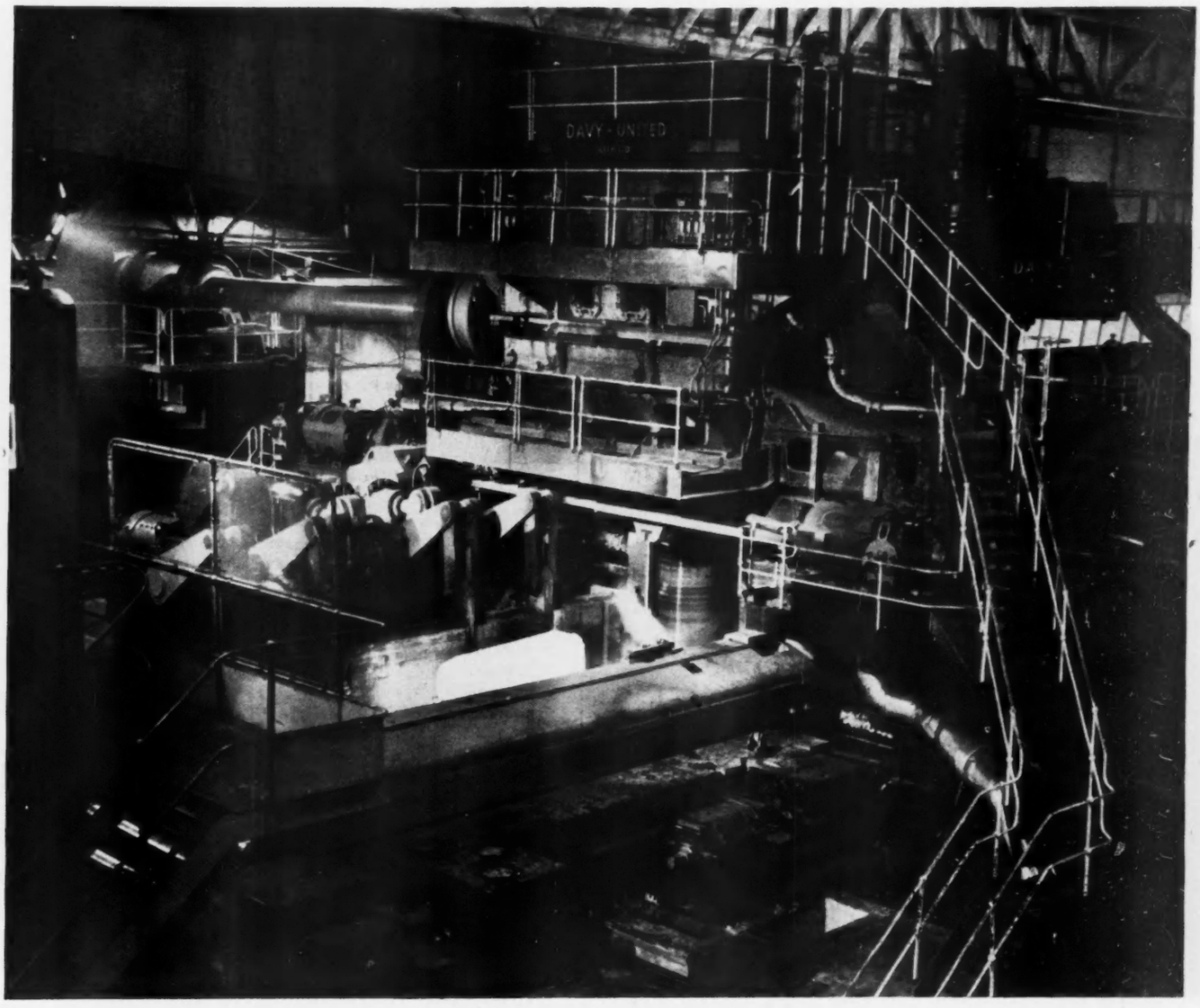

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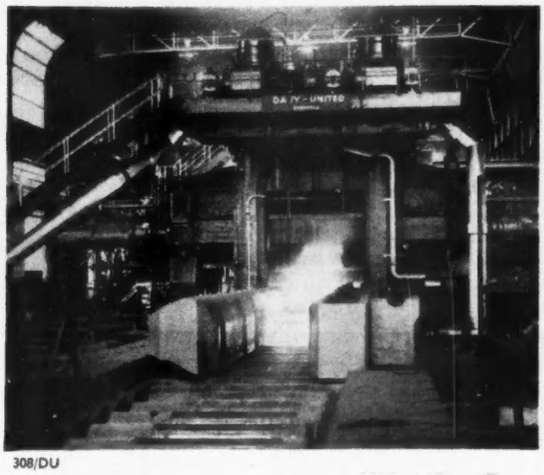

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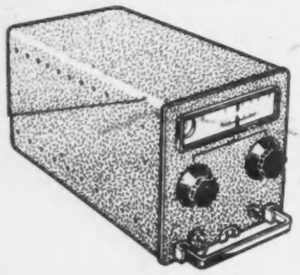

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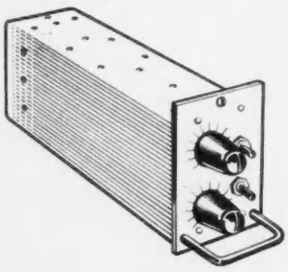
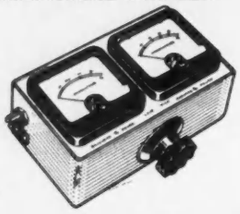
TRANSISTOR GALVANOMETER AMPLIFIER

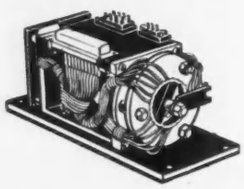


This amplifier has been designed to drive viscous damped recording galvanometers which normally have a resistance of 50 ohms and a working range of D.C. to 2 Kc/s in frequency. The amplifier has a switched attentuator at its input and will accept single ended or push-pull signals from ± 1 Millivolt to ± 500 volts and will feed a maximum of ± 50 Milliamps to the galvanometer. There is also a range of ancillary units available for use with this Amplifier as part of a comprehensive instrumentation system. *Standard specification: Dimensions: 4¼ in. x 3¾ in. x 10 in.: Frequency response; Flat from DC to 2 Kc/s, 5% down at 3 Kc/s, 3db down at 6 Kc/s; Noise level: Less than 10 Microvolts; Input impedance: 40,000 ohms on range 5, 110,000 ohms all other ranges; Gain: Maximum 7·5 Milliamps/Millivolt, minimum 0.04 Milliamps/Volt; Power requirements: ± 6 Volts D.C. 220 Milliamps each line.*

DIRECTIONAL COUPLER



Of the 'Loop' type, suitable for measurements of RF power and Standing Wave Ratio in coaxial cables. Directional properties are largely unaffected by frequency changes, so coupler may be used to help obtain optimum termination of a 52 ohm coaxial system up to 600 M/cs. *Standard Specification: Size 7" x 4" x 2½"; weighs 4 lbs. 3 ozs.; Power Measurement Range is Low range 1 w.cw.max. High range 5 w.cw.max.; less than 1% attenuation; better than 2% accuracy at frequency of calibration.*



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Based on a conception of British Ministry of Supply's Research and Development Establishment, gives facilities previously unobtainable from mechanical sampling devices. The Standard Model enables two 24 channel banks to be sampled at speeds up to 200 r.p.s.

All devices are adaptable to suit customers' own requirements. For further information consult.

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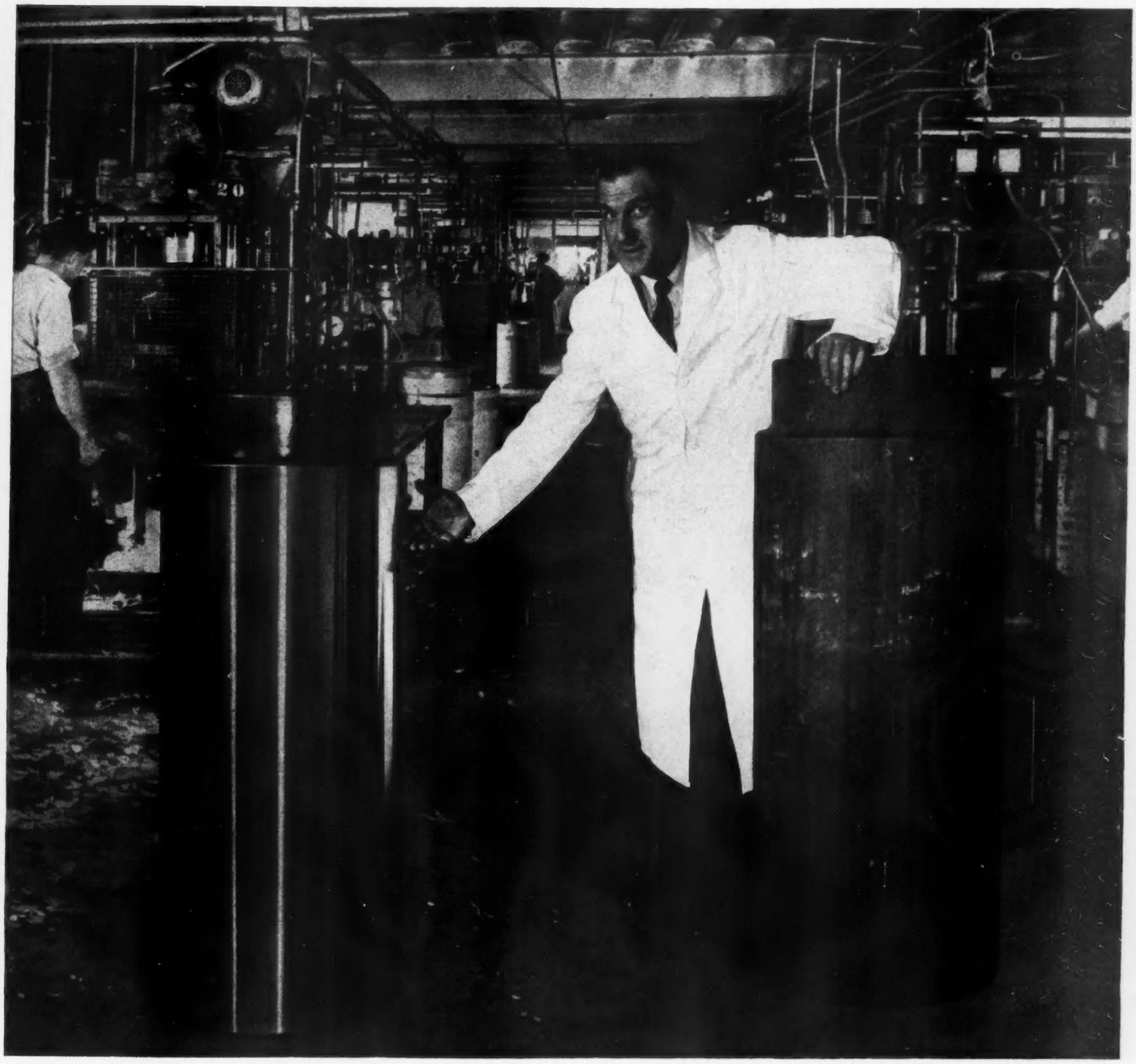

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Here's the perfect before and after story of the Fescol process. The ram on my left is untreated, and has become corroded and pitted by wear and corrosion, in this condition it has reached the end of its useful life. Now look at the other ram, it was just the same before it was 'Fescol'-ised and now it will retain its new look almost indefinitely. That's because the nickel or chromium protection provided by the Fescol process withstands wear and corrosive attack being an even harder, more durable surface than the original metal. The process has proved so successful in the salvage of worn rams that now we have them treated before installation. Then we more or less forget about them.

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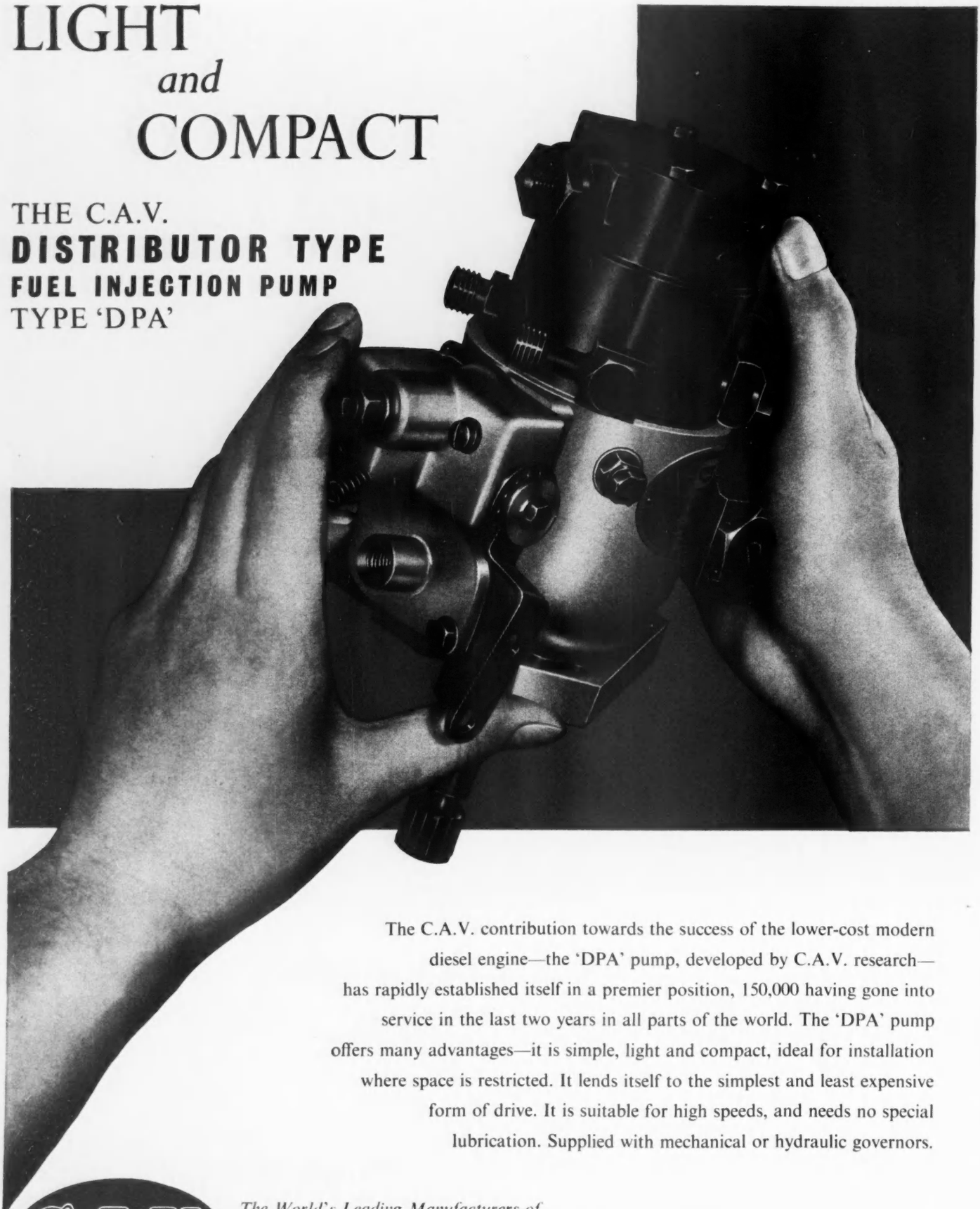

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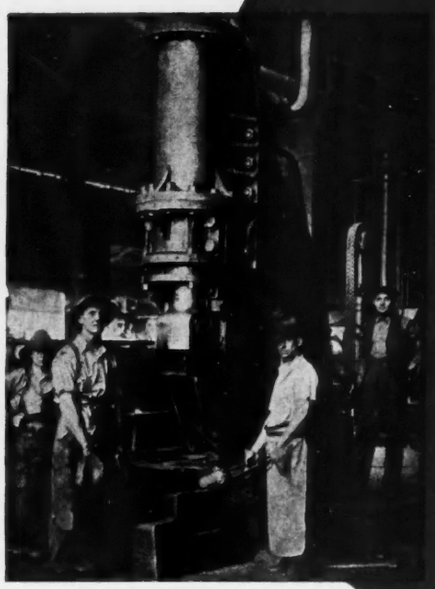

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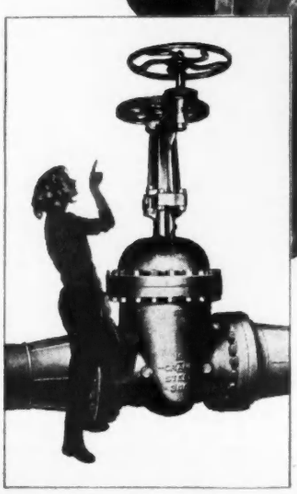
"How do Crane giant valves help to feed my piglets?"



THE pigs, of course, couldn't care less, but the farmer's wife finds it amazing that Crane giant valves help to keep them well fed. However at the Pfizer Organisation, a large chemical producing factory, there is a department specialising in preparations used in pig feeding. And here these valves are performing vital duties during the early processing stages. The industries which Crane giant valves serve are varied and numerous . . . and the giant valve is only one among a wide variety of Crane valves—ranging from ½" to 24"—each with a tradition of reliable, efficient service. Crane's reputation for reliability lies in their high standard of design, production and precision testing methods.

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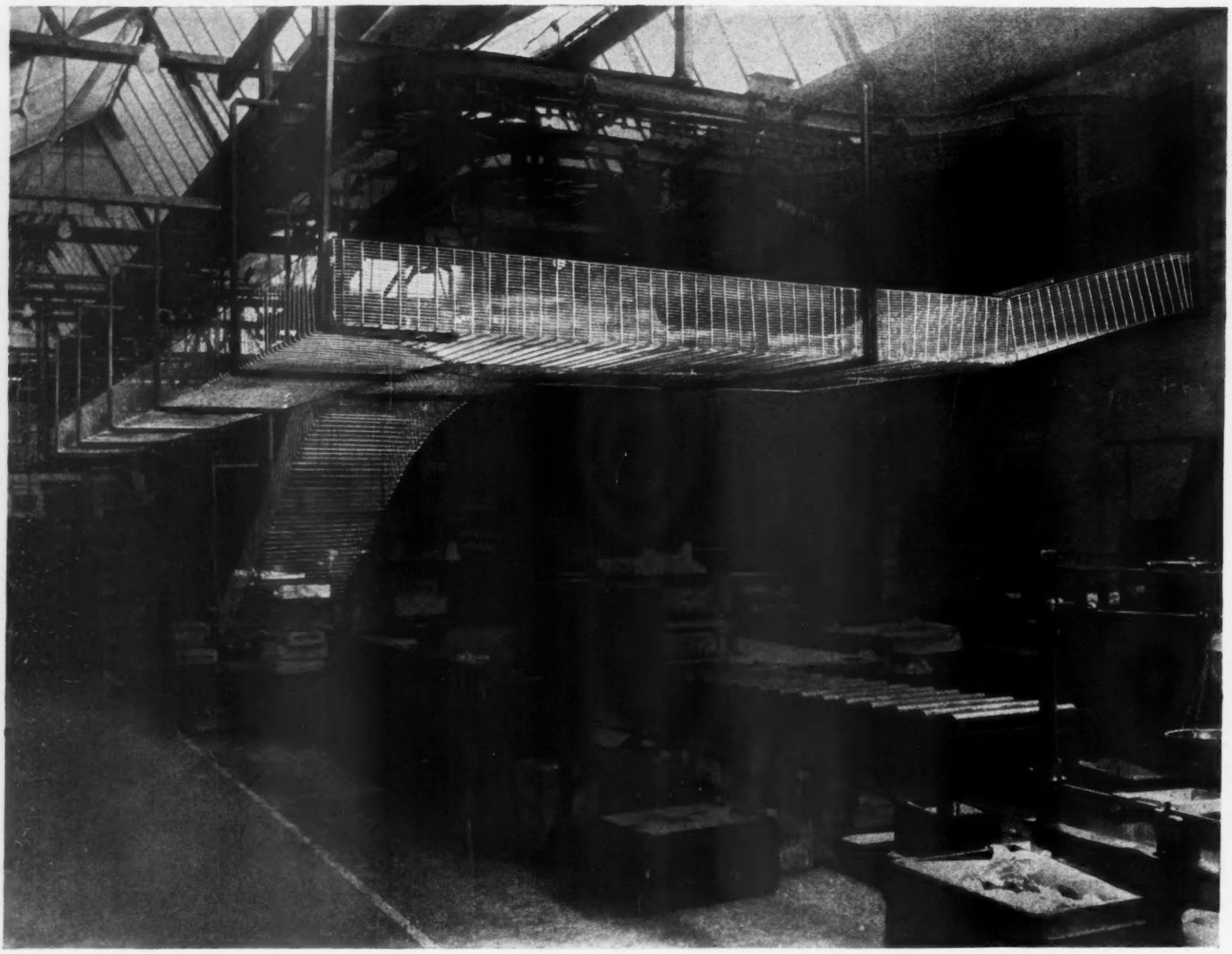

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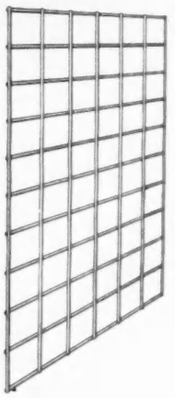

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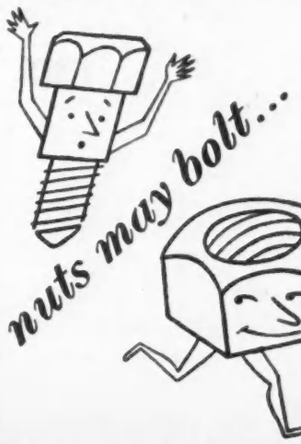

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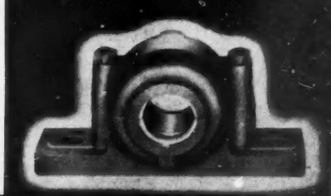

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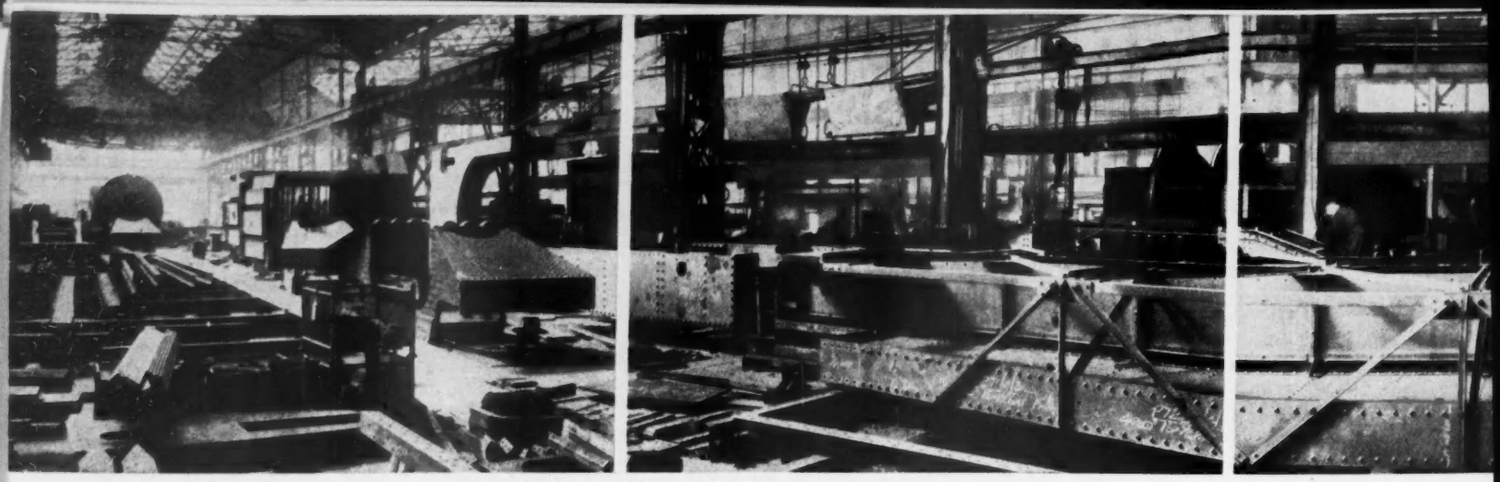
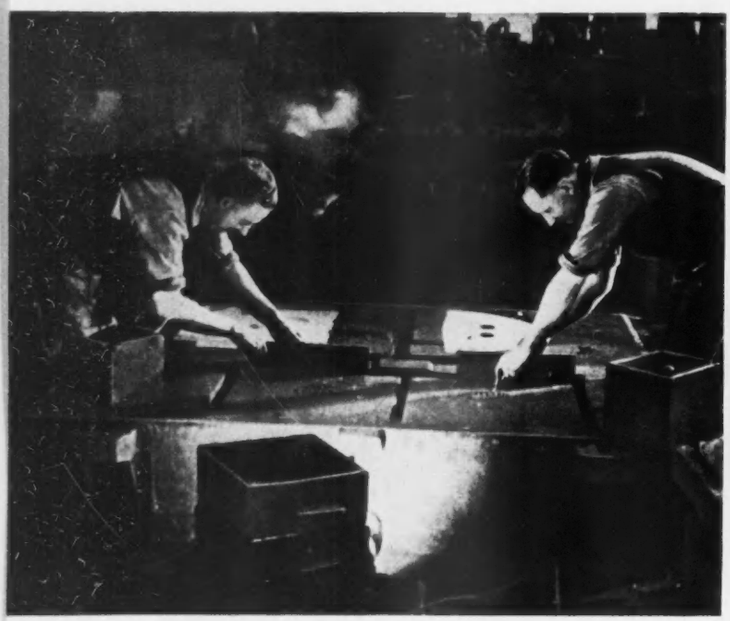


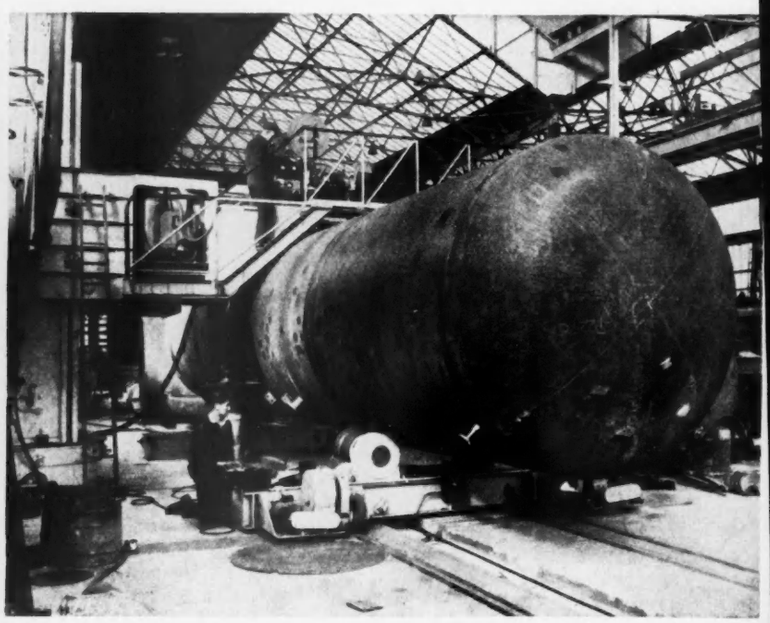
Panoramic view of the extended constructional shops

NEWTON CHAMBERS

New production facilities

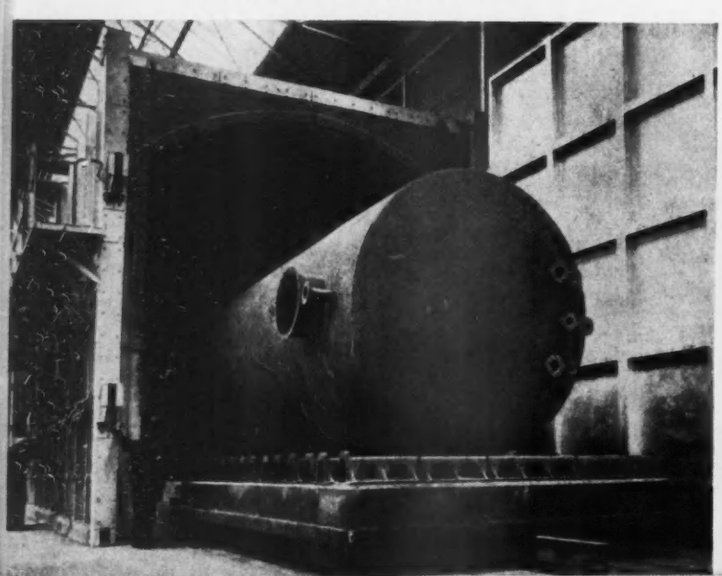


Preparing to cast in Meehanite metal in the foundries.

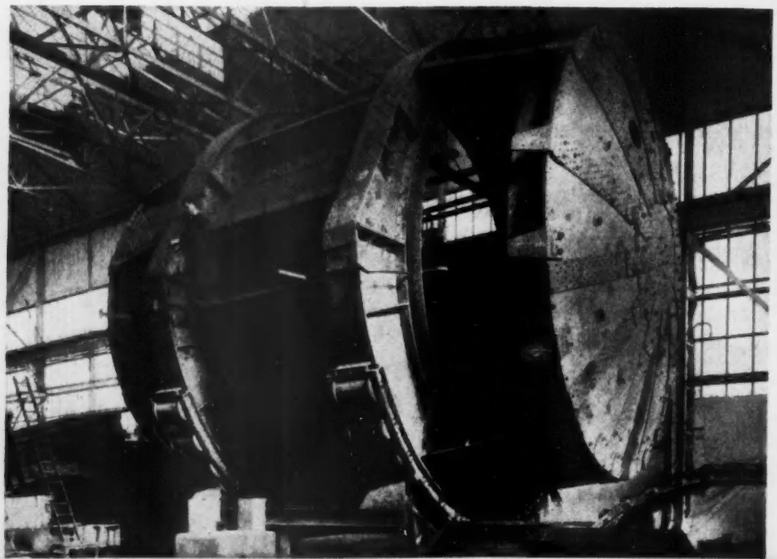


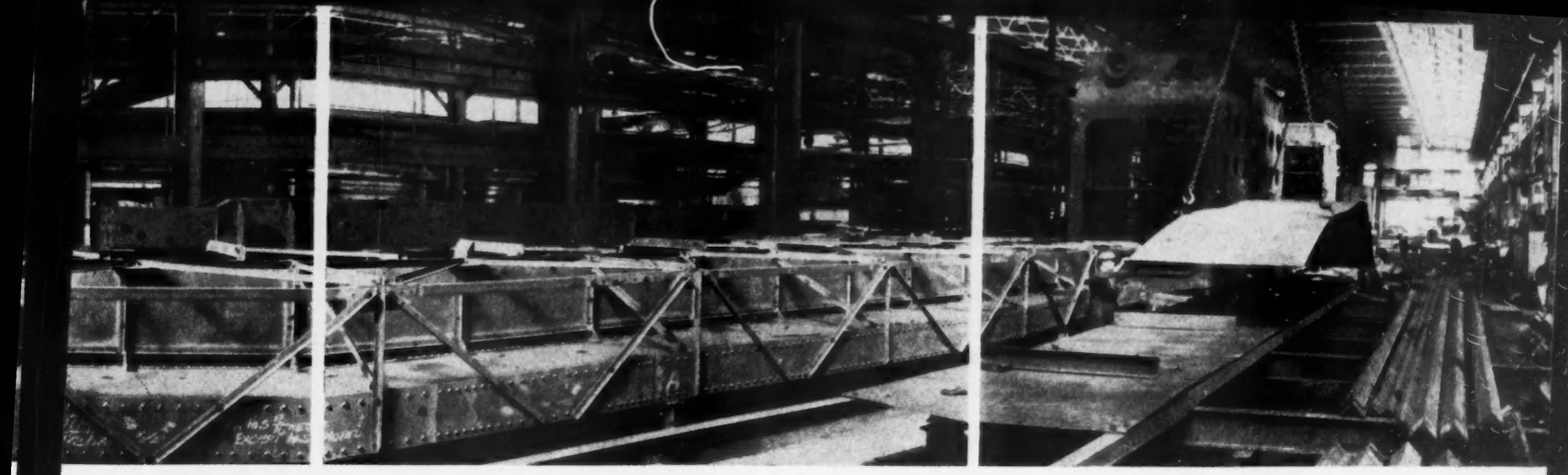
Automatic welding of a large pressure vessel.

The large new stress relieving furnace in use.



Hot metal mixer of 800-tons capacity under assembly.





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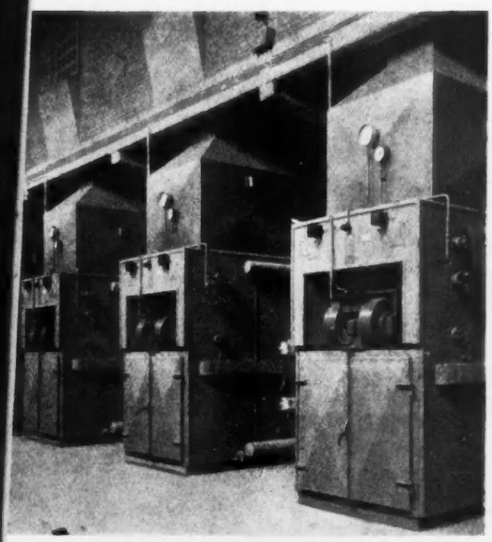

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A Redfyre "Emma" Boiler installation.

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ENGINEERING DIVISION

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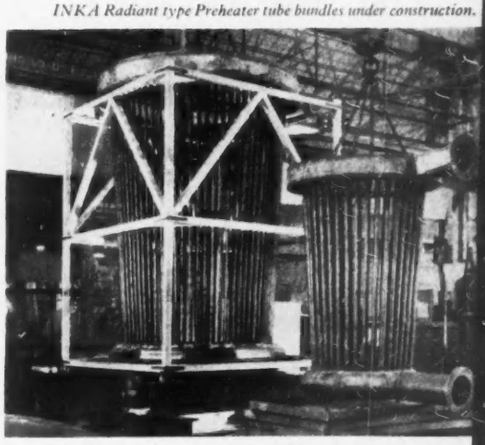
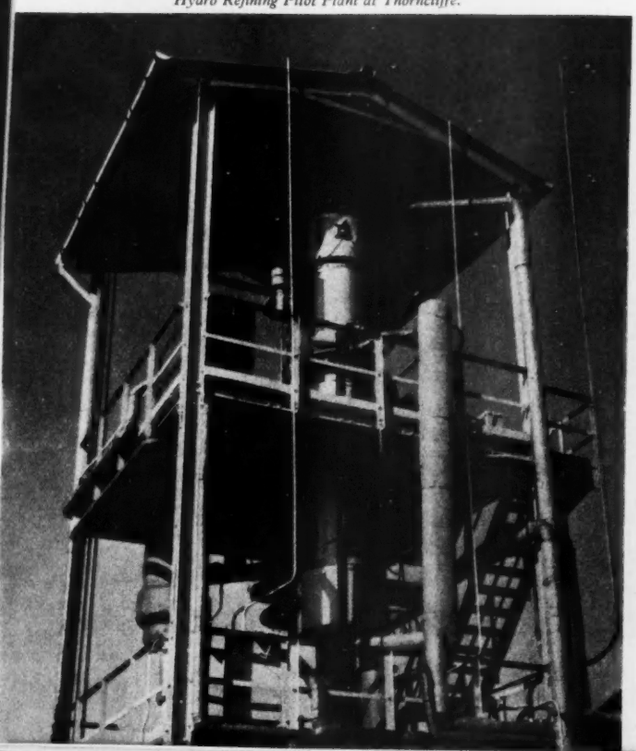
INKA Radiant type Preheater tube bundles under construction.

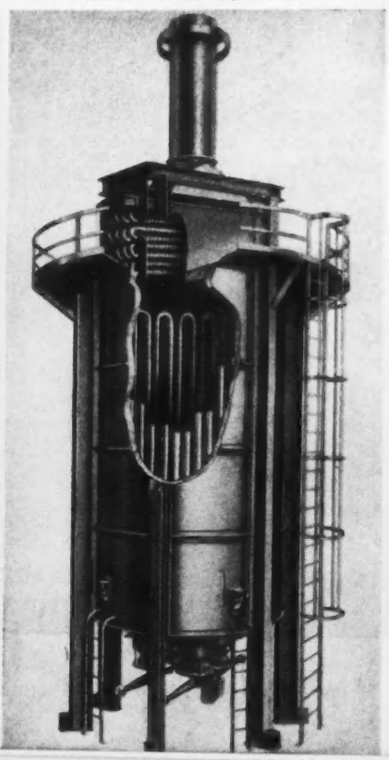


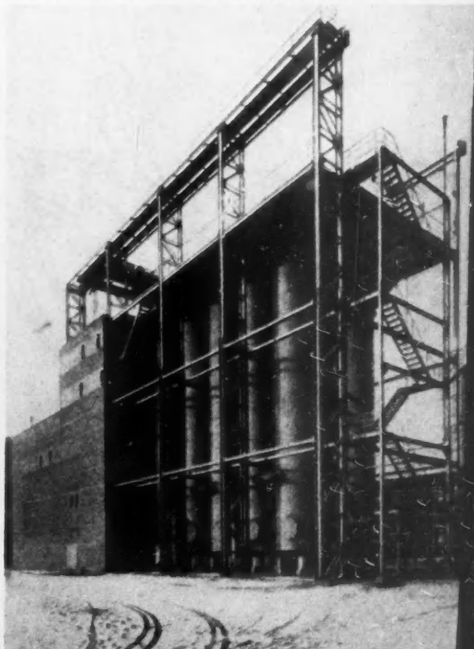
A typical Newton Chambers Bischoff high pressure purification pla

Hydro Refining Pilot Plant at Thorncliffe.



Struthers Wells direct-fired heaters.





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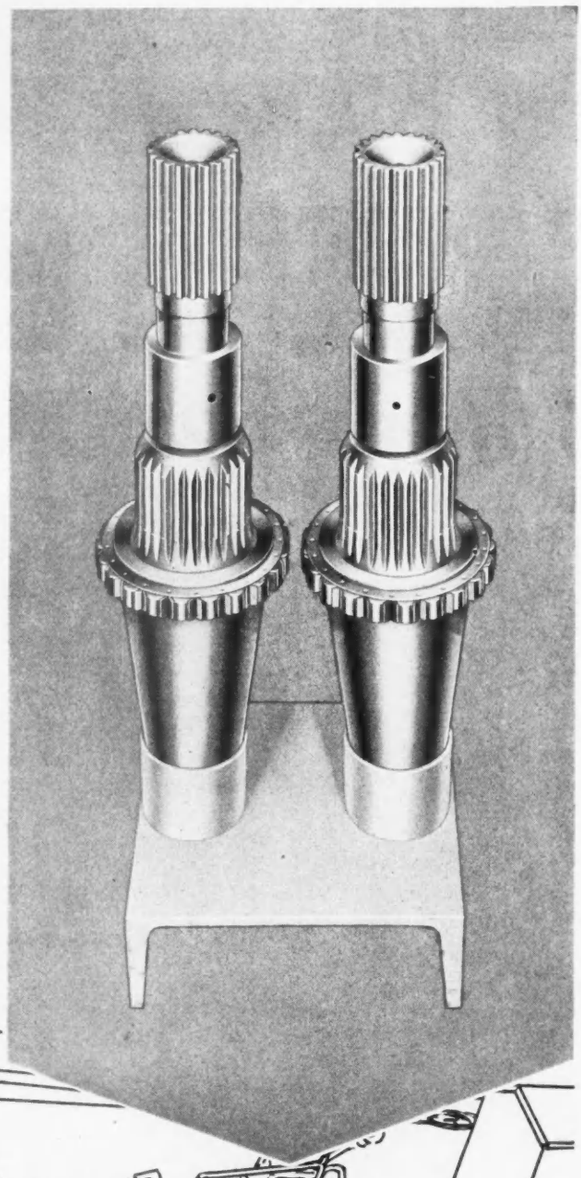
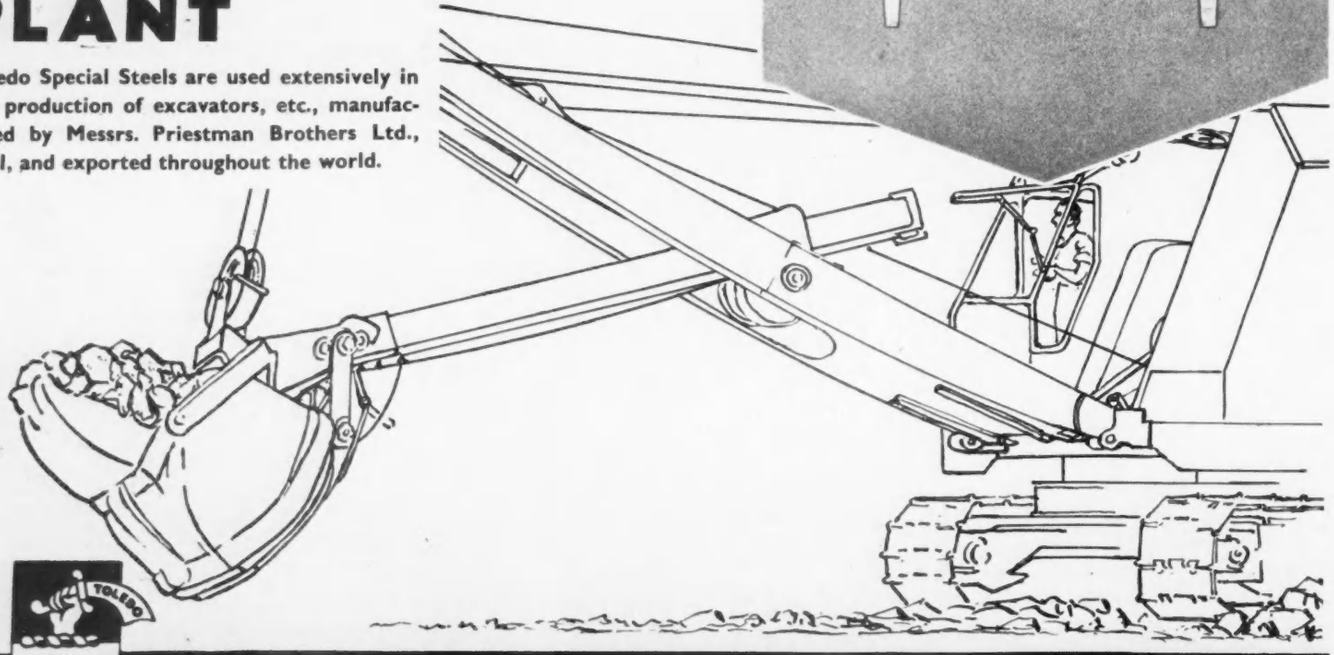


Involute splined Tru-Speed Gear Shaft made of Toledo Steels for Priestman Excavators



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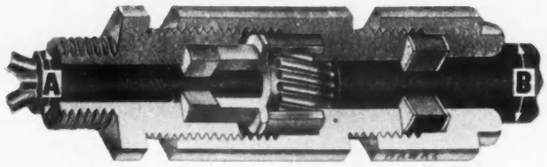

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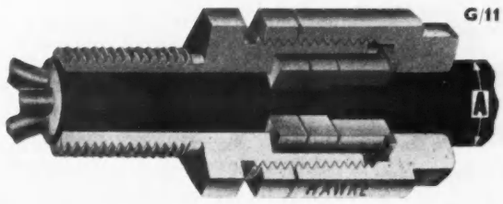

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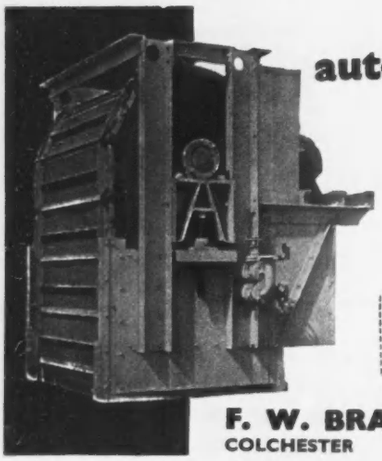

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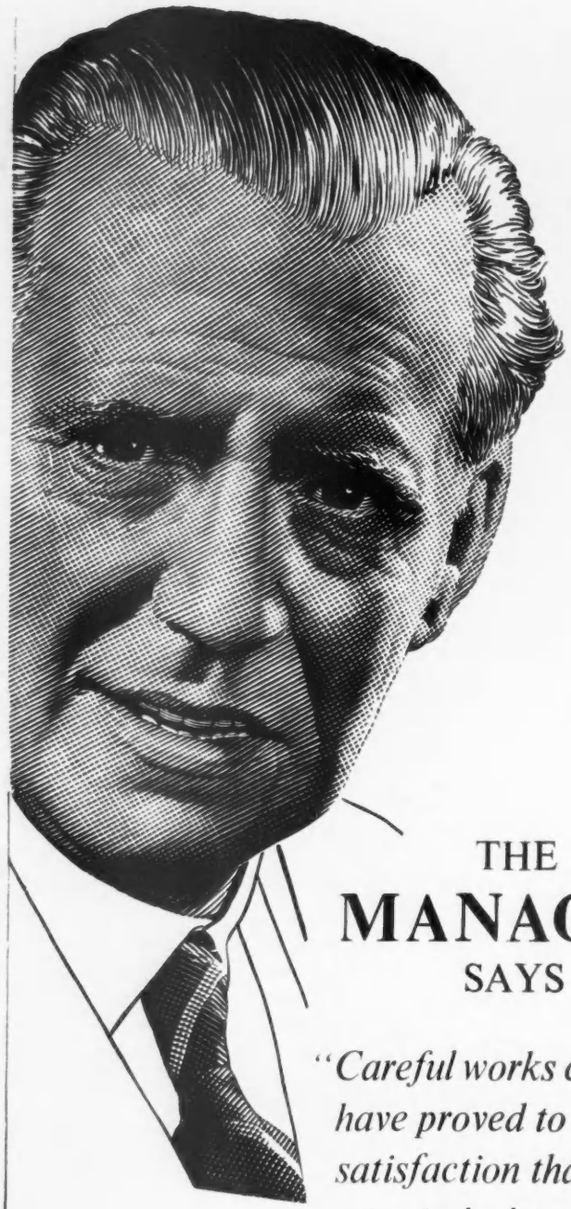

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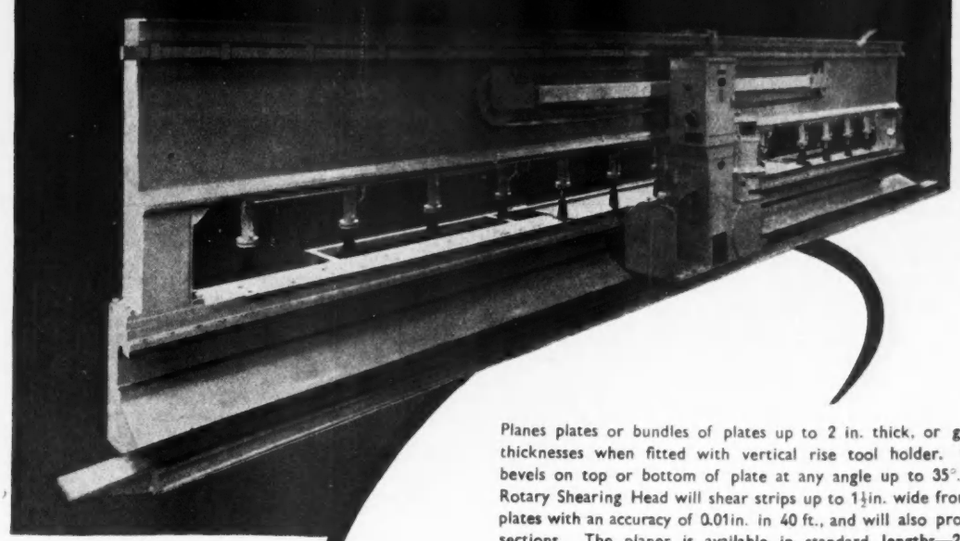

SERIES II
TRU-EDGE PLANER

An improved version of this well established machine for the preparation of plate edges with accuracy and speed.

In two forms: with overhead beam and hydraulic jack clamping (*illustrated*) or with beam type clamping.

Available with
ROTARY SHEARING HEAD

Planes plates or bundles of plates up to 2 in. thick, or greater thicknesses when fitted with vertical rise tool holder. Planes bevels on top or bottom of plate at any angle up to 35°. The Rotary Shearing Head will shear strips up to 1¼in. wide from ⅝in. plates with an accuracy of 0.01in. in 40 ft., and will also provide J sections. The planer is available in standard lengths—25, 30, 35 and 40 ft.

HUGH SMITH MACHINE TOOLS *include:*
- HEAVY SHIPYARD PLATE BENDING ROLLS
- BULKHEAD FLANGING PRESSES
- COLD FRAME BENDERS
- PLATE STRAIGHTENING ROLLS
- FLANGING PRESSES
- GAP PRESSES OF ALL TYPES
- ETC., ETC.

HUGH SMITH & CO. (POSSIL) LTD
HAMILTON HILL RD., GLASGOW, N.2
Telephone: POSSIL 8201/4 *Telegrams: "POSSIL, GLASGOW"*

MacLellan

EXPANSION JOINTS

in RUBBER

Rubber Expansion Joints—particularly MacLellan Rubber Expansion Joints—have many advantages over other joints under certain conditions.

Rubber Expansion Joints compensate for expansion or contraction *and* shear. Rubber dampens shock, vibration and noise transmission, and has good recovery.

Rubber Expansion Joints are easily installed, gaskets are unnecessary and there is no electrolysis with salt water.

MacLellan can supply Expansion Joints in natural or synthetic rubber, reinforced for pressure and vacuum, to withstand exposure to weather, heat, oil, etc.

SIZE—Circular joints have been made up to 10ft. bore; rectangular joints up to 16ft. per side. Developments are in hand for even greater sizes. This illustration shows a 5ft. joint.

•

Technical and consultative service. Qualified representatives strategically placed across the country.

MacLellan *RUBBER*
CARRIES INDUSTRY FORWARD

George MacLellan & Company Limited
MARYHILL, GLASGOW N.W. *Telephone MARyhill 5111/9*

Makers of rubber for industry for over 80 years: expansion joints, conveyor belts for outdoor and underground service, suction and discharge hose, rubber jointing and cut joints, Macbond rubber and ebonite lining and covering, Mactex rubber buckets, roller and idler covers, asbestos millboard, protective clothing.

CLASSIFIED ADVERTISEMENTS

AGENCIES · DIRECTORS · PARTNERSHIPS · SITUATIONS VACANT · EDUCATIONAL PATENTS · BUSINESS OPPORTUNITIES · MISCELLANEOUS · PUBLIC APPOINTMENTS BUSINESSES and PREMISES · TENDERS

Lineage Rate. 4/- per line of approximately 6 words. Minimum 16/-.

Inch Rate. 48/- per single column inch and *pro rata*. 12 lines to 1 inch. There are reduced rates (*i.e.*, not on a *pro rata* basis) for advertisements of ¼-page (12 column inches) and upwards, e.g., ¼-page £25 10s. ½-page £48. Full page £90.

AUCTION SALES · FOR HIRE · MACHINERY, etc., WANTED · SITUATIONS WANTED DRAWING AND DESIGN SERVICES · FOR SALE · SUB-CONTRACTING

Lineage Rate. 3/6 per line of approximately 6 words. Minimum 14/-.

Inch Rate. 42/- per single column inch and *pro rata*. 12 lines to 1 inch. There are reduced rates (*i.e.*, not on a *pro rata* basis) for advertisements of ¼-page (12 column inches) and upwards, e.g. ¼-page £22. ½-page £41 10s. Full page £78.

Series Discounts. For advertisements 1 inch and upwards. 6 insertions 5%. 13 insertions 10%. 26 insertions 15%.

Run-On and Semi-Displayed Styles. Both these styles are available for single column width advertisements of any depth up to 12 inches.

Displayed and Illustrated Styles. The minimum size for a Displayed advertisement is 3 inches single column, for an illustrated advertisement it is a ¼-page (12 column inches). Thereafter the sizes for both progress in steps 3 inches deep across 1, 2, 3 or 4 columns.

Use of Box Number. 2/- which includes forwarding of replies.

Copy Dates. "Run-on" and "Semi-displayed" advertisements by noon Tuesday for publication on Friday same week. "Displayed" and "Illustrated" advertisements by noon Friday for publication on following Friday. All advertisements three days earlier if proofs are required.

***Advertisements for publication should be addressed to:*—Classified Advertisement Dept., "The Engineer", 28 Essex Street, Strand, London, W.C.2.**

Urgent advertisements may be telephoned to CENtral 6565

PUBLIC APPOINTMENTS

COLLEGE OF TECHNOLOGY, BIRMINGHAM

(DESIGNATED COLLEGE OF ADVANCED TECHNOLOGY)

DEPARTMENT OF PRODUCTION ENGINEERING

APPOINTMENTS

Applications are invited for the posts of
READER IN METROLOGY AND/OR MACHINE TOOLS.
SENIOR LECTURER IN PRODUCTION ENGINEERING.
LECTURER IN PRODUCTION ENGINEERING.

Candidates for the Readership must have previous experience in research. The successful candidate will be required to initiate research and undertake a limited amount of lecturing on advanced topics.

Salary scales :
Readers : (men) £1627 10s. by £52 10s. to £1890.
Senior Lecturers : (men) £1417 10s. by £52 10s. to £1627 10s.
Lecturers : (men) £1260 by £31 10s. to £1417 10s.

In fixing the commencing salary, account may be taken of industrial, professional or research experience up to the maximum of the scale.

Further particulars and forms of application from the Registrar, College of Technology, Gosta Green, Birmingham, 4. Applications to be received within 18 days of this advertisement.

K. R. PILLING,
E5158 Clerk to the Governing Body.

MANCHESTER COLLEGE OF SCIENCE AND TECHNOLOGY

(FACULTY OF TECHNOLOGY IN THE UNIVERSITY OF MANCHESTER)

APPOINTMENT OF LECTURERS OR ASSISTANT LECTURERS IN MECHANICAL ENGINEERING

The Governing Body invites applications for LECTURESHIPS or ASSISTANT LECTURESHIPS in MECHANICAL ENGINEERING in the Manchester College of Science and Technology, with corresponding title and status in the University of Manchester.

The Department covers a very wide range of aspects of Mechanical and Production Engineering and all members of staff are expected to undertake, assist in, or supervise research in some appropriate field.

Salary :
LECTURER : £900 by £50 to £1350 by £75 to £1650.
ASSISTANT LECTURER : £700 by £50 to £850.

Commencing salary according to qualifications and experience. F.S.S.U. and family allowances.

Conditions of appointment and form of application may be obtained from the Registrar, The Manchester College of Science and Technology, Manchester, 1. The last day for the receipt of applications is Saturday, 28th March, 1959. E5138

UNIVERSITY OF SYDNEY

AUSTRALIA

LECTURESHIP/SENIOR LECTURESHIP IN MECHANICAL ENGINEERING

Applications are invited for the above position.

The salary for a SENIOR LECTURER is within the range £A2200 by £A80 to £A2600 per annum ; for a LECTURER within the range £A1500 by £A90 to £A2100 per annum. In each case cost of living adjustment will be allowed. The salary is subject to deductions under the State Superannuation Act. The commencing salary will be fixed according to the qualifications and experience of the successful applicant.

Under the Staff Members' Housing Scheme in cases approved by the University and its Bankers, married men may be assisted by loans to purchase a house.

Further particulars and information as to the method of application may be obtained from the Secretary, Association of Universities of the British Commonwealth, 36, Gordon Square, London, W.C.1.

Applications close, in Australia and London, on 30th April, 1959. E5142

PUBLIC APPOINTMENTS

UNIVERSITY OF BIRMINGHAM

WILMOT BREEDEN RESEARCH FELLOWSHIP, 1959

Applications are invited for a RESEARCH FELLOWSHIP to be held in association with the University of Birmingham. The value of the Fellowship, which is for a two-year term, is £1000 per annum.

A candidate for the Fellowship should normally have had two or three years' research or industrial experience. He must be acceptable to the University and would be expected to have an Honours Degree of a University in the British Commonwealth, a Diploma in Technology or an equivalent qualification.

The Wilmot Breeden Fellow will engage in an enterprise of such a character as to require the facilities both of the University and the Company, and his time will be divided between the two. The activities with which the Company is especially concerned include Mechanisms, Electro-Chemistry, Metal Finishing, Metallurgy, Metal Formation, Hydraulics, Electronics.

Full details may be obtained on application to the Secretary, Wilmot Breeden Limited, Amington Road, Birmingham, 25. Final applications must be received by the Secretary before 1st May, 1959.

E5166

UNIVERSITY OF SYDNEY

AUSTRALIA

SENIOR LECTURESHIP IN CIVIL ENGINEERING

Applications are invited for the above position. Candidates should have an Honours Degree in Engineering and have been engaged in teaching or research in the subject Materials. Preference will be given to applicants having additional qualifications in either Metallurgy or Metal Physics.

The salary for a SENIOR LECTURER is within the range £A2200 by £A80 to £A2600 per annum, plus cost of living adjustment and will be subject to deductions under the State Superannuation Act. The commencing salary will be fixed according to the qualifications and experience of the successful applicant.

Under the Staff Members' Housing Scheme, in cases approved by the University and its Bankers, married men may be assisted by loans to purchase a house.

Further particulars and information as to the method of application may be obtained from the Secretary, Association of Universities of the British Commonwealth, 36, Gordon Square, London, W.C.1.

Applications close, in Australia and London, on 21st April, 1959. E5143

SURREY EDUCATION COMMITTEE

WIMBLEDON TECHNICAL COLLEGE
GLADSTONE ROAD, S.W.19

GRADE "B" ASSISTANT

GRADE "B" ASSISTANT required as soon as possible to teach Mechanical Engineering subjects to O.N.C. level, together with Science and Calculations to Final Machine Shop Engineering standard. Preference will be given to Graduates or the equivalent. Salary, Burnham Scale, £682 10s. by £26 5s. to £1076 5s., plus London allowance.

Application form and further particulars obtainable from Principal, to whom completed applications should be sent within two weeks of the date of advertisement. E5178

UNIVERSITY OF NOTTINGHAM

HIVES CHAIR OF THERMODYNAMICS

APPOINTMENT

The Council invites applications for the election to the recently established HIVES CHAIR OF THERMODYNAMICS within the Department of Mechanical Engineering. Salary £2350, with membership of the Universities' Superannuation Scheme and Children's Allowances. Conditions of Appointment and Form of Application, which should be returned by 30th April, 1959, from the Registrar. E5119

PUBLIC APPOINTMENTS

UNIVERSITY COLLEGE OF SWANSEA

ASSISTANT LECTURESHIPS OR LECTURESHIPS

Applications are invited from suitably qualified candidates for ASSISTANT LECTURESHIPS or LECTURESHIPS in the following subjects :
Civil Engineering
Mechanical Engineering
Chemical Engineering.

Salary scales :
Assistant Lectureships : £700 by £50 to £850 per annum.
Lectureships : £900 by £50 to £1350 by £75 to £1650 per annum.
F.S.S.U. benefits and family allowances.

Further particulars can be obtained from the Registrar, University College, Singleton Park, Swansea, by whom applications must be received not later than Saturday, April 4, 1959. E5075

COUNTY BOROUGH OF SWANSEA

WATER DEPARTMENT

PRIMARY DISTRIBUTION SYSTEM—EASTERN AREA

REINFORCED CONCRETE RESERVOIR, MAINS AND ANCILLARY WORKS

RESIDENT ENGINEER

The Corporation is about to undertake a scheme for the improvement of water supplies in the Borough involving the design and construction of a pumping station, 3 million gallon capacity reservoir, and 5 miles of mains, 24in. to 9in. diameter.

Applications are invited for the appointment of a RESIDENT ENGINEER to assist with the design and supervise the carrying out of the above works. The salary will be £1200 per annum and it is anticipated that the works will be completed within 2½ years.

Applicants must be Corporate Members of the Institution of Civil Engineers and have had specialised experience of the design and execution of reinforced concrete works, and be competent to supervise the construction of such works and the laying and testing of large mains.

The appointment will be subject to the National Scheme of Conditions of Service, the Local Government Superannuation Act, and a satisfactory medical report. The appointment will be temporary and terminable by one month's notice on either side.

Applications, stating age, qualifications, any former Local Government service, present and previous appointments, and the names of two referees must be forwarded to the Borough Water Engineer and Manager, The Guildhall, Swansea, not later than the 19th March, 1959.

Canvassing will disqualify.

T. B. BOWEN,
The Guildhall, Town Clerk.
Swansea,
19th February, 1959. E5053

DEPARTMENT OF MAIN ROADS, NEW SOUTH WALES, AUSTRALIA

CIVIL ENGINEERS

Applications are invited from Graduates (or Undergraduates in their final year) in Civil Engineering of a recognised British or Irish University, for appointment to the staff of the Department of Main Roads, New South Wales, the State Road Authority for construction of roads and bridges.

On appointment, applicants may be engaged at the Department's Head Office, Sydney, on the design of reinforced concrete and steel bridges, or on main road construction and maintenance, either in the Metropolitan Area or the country.

Commencing salary according to qualifications and experience, will be within the range £A1185 to £A1410 per annum, with annual progression, subject to technical competence, to £A2095 per annum. Appointees will be eligible to contribute to the State Superannuation Fund after six months.

Appointee's full fare from England to Australia will be met by the Department, subject to a three years' service guarantee bond being completed. Appointment will be subject to passing a medical examination and preference will be given to applicants not more than 30 years of age.

Applications should be made on forms obtainable from the Agent General for New South Wales, 56, Strand, London, W.C.2. E5170

PUBLIC APPOINTMENTS

ROYAL NAVAL SCIENTIFIC SERVICE

SENIOR SCIENTIFIC OFFICERS AND SCIENTIFIC OFFICERS

Royal Naval Scientific Service requires SENIOR SCIENTIFIC OFFICERS and SCIENTIFIC OFFICERS for Establishments in London area, Baldock, Portsmouth, Portland, Poole and Rosyth. Main requirements are for PHYSICISTS, MECHANICAL ENGINEERS, ELECTRONIC ENGINEERS and MATHEMATICIANS in areas specified. The following particular vacancies also exist : Mathematician : for applied research of basic nature on stability of underwater vehicles ; knowledge of theoretical hydrodynamics and theory of control systems an advantage : London area. Mechanical Engineer : with sound knowledge of basic principles of thermo and fluid dynamics, to carry out research programme in a particular field of applied hydrodynamics. Experience in modern methods of design and research on axial flow compressors, turbines or pumps an advantage : London area. Mechanical Engineers : for design and development of underwater devices : Portland area. Physical Chemist : with specialised knowledge of rubber technology : Poole area. Chemists : Physical and Inorganic : Poole, Baldock and London areas. Candidates must normally be natural born British subjects of natural born British parents, with First or Second Class Honours Degrees. S.S.O.'s must have had three years' post-graduate experience and be not less than 26 years of age.

Salaries (men) : S.S.O., £1233–£1460 ; S.O., £655–£1150 (London)—somewhat lower in provinces. Appointments are unestablished (with F.S.S.U. benefits), but opportunities may occur for those between ages of 21 and 32 to compete for established posts.

Forms from M.L.N.S., Technical and Scientific Register (K), 26, King Street, London, S.W.1 (quote A.500/8A). E5161

GOVERNMENT OF NORTH BORNEO

NORTH BORNEO RAILWAYS

ASSISTANT MECHANICAL ENGINEER

To assist the Mechanical Engineer in the running running maintenance and workshop maintenance and repairs of engines, rolling stock and plant of the North Borneo Railways. The officer will also be required to assist in the training of subordinate staff in the department.

Contract appointment for three years in salary range £1302 to £2324 p.a., with gratuity payable on satisfactory completion of contract. Free passages. Quarters at low rent. Generous home leave.

Candidates must be A.M.I.Mech.E., having completed a full mechanical engineering pupilage or apprenticeship with a railway administration, followed by not less than ten years of railway mechanical engineering work, including drawing-office, running shed and workshops practical experience, and be between 40 and 45 years of age.

Write, Director of Recruitment, Colonial Office, London, S.W.1, giving briefly age, qualifications and experience, quoting BCD 110/21/04. E5118

COUNTY BOROUGH OF PRESTON

PORT OF PRESTON AUTHORITY

ASSISTANT ENGINEER (CIVIL)

Applications are invited for the post of ASSISTANT ENGINEER (CIVIL) in the Chief Engineer's Department of the Port of Preston Authority.

Candidates should be Corporate Members of the Institution of Civil Engineers or hold equivalent qualifications, and have good experience in design, specifications, construction and maintenance of civil engineering works. Dock and harbour experience is preferable, but not essential.

Salary, Grade A.P.T. IV (£1025 by £25 to £1175).

The appointment will be subject to the Local Government Superannuation Acts, to the National Scheme of Conditions of Service, and to one month's notice on either side.

Application forms may be obtained from the undersigned, to whom they should be returned not later than 31st March, 1959.

W. E. E. LOCKLEY,
Town Clerk.
Municipal Building,
Preston, Lancs. E5056

PUBLIC APPOINTMENTS

COUNTY BOROUGH OF SWANSEA

WATER DEPARTMENT

APPOINTMENTS

Applications are invited for the following appointments to the permanent staff :—

(a) SUPPLY WORKS ENGINEER.
(b) ASSISTANT ENGINEER (PLANNING).
(c) JUNIOR ENGINEERING ASSISTANT.

The salary for posts (a) and (b) will be in accordance with Grade A.P.T. IV (£1025–£1175), and the salary for post (c) will be in accordance with Grade A.P.T. I (£575–£725) of the National Joint Council for Local Authorities Administrative, Professional and Technical and Clerical Services.

Applicants for post (a) must be Corporate Members of the Institution of Civil Engineers and have had experience of the maintenance and operation of impounding reservoirs, filtration plants and large mains.

Applicants for post (b) must be Corporate Members of the Institutions of Civil or Structural Engineers, and have considerable experience of the design of reinforced concrete structures, preferably of a type for the retention of liquids. Experience in the design of pipelines and hydraulic calculation will be an advantage.

Applicants for post (c) should have experience in drawing-office work and be competent draughtsmen. Preference will be given to those possessing technical qualifications or who are studying with a view to qualifying as civil engineers.

All appointments are subject to the National Scheme of Conditions of Service, the Local Government Superannuation Act and a satisfactory medical report.

The Corporation will endeavour to assist successful applicants for posts (a) and (b) with housing accommodation if married.

Applications, stating age, qualifications, all former Local Government service, present and previous appointments and experience, and the names of two referees must be forwarded to the Borough Water Engineer and Manager not later than the 19th March, 1959.

Canvassing will disqualify.

T. B. BOWEN,
Town Clerk.

The Guildhall,
Swansea,
19th February, 1959. E5052

NORTH OF SCOTLAND HYDRO-ELECTRIC BOARD

EDINBURGH

ENGINEERING ASSISTANT

Applications are invited for the post of ENGINEERING ASSISTANT in the Hydraulic Engineer's Department of the Board's Head Office in Edinburgh. Applicants must be Corporate Members of the Institution of Civil Engineers and have experience in the investigation and design of Hydro-Electric Schemes or of Water Supply Schemes. Salary commencing at a point within the range £1090–£1375 (N.J.B. Schedule B, Class AX/CX, Grades 5/4) depending on experience and qualifications. Superannuation Scheme.

Application form obtainable from The Secretary, 16, Rothesay Terrace, Edinburgh. 3, should be returned by 28th March, 1959. E5149

LIVERPOOL REGIONAL HOSPITAL BOARD

PRINCIPAL ASSISTANT ENGINEER II (MECHANICAL)

Applications invited from suitably qualified persons for the permanent pensionable appointment of PRINCIPAL ASSISTANT ENGINEER II (MECHANICAL) on the staff of the Regional Engineer.

Salary Scale, £1195 rising to a maximum of £1420.

The person appointed will be required to take charge of the Mechanical Section of the Department. Applicants should hold Corporate Membership of I.Mech.E., and have had considerable experience on heating and ventilating schemes, kitchen and laundry layouts, fuel efficiency and steam boiler plant installations. Experience on hospital installations desirable.

Applications, stating age, qualifications, experience, present and previous posts, with the names and addresses of three referees (2 technical), to reach me at 55, CASTLE STREET, LIVERPOOL, 2, by 3rd April, 1959.

VINCENT COLLINGE,
Secretary to the Board.
E5172

PUBLIC APPOINTMENTS

NATIONAL COAL BOARD

DURHAM DIVISION

AREA CENTRAL WORKSHOPS MANAGER

Applications are invited for the above post in No. 2 Area of the Division. The workshops are situated near Houghton-le-Spring.

The appointment will carry a salary within the range £1250 to £1850. The starting salary will be in accordance with the qualifications and experience of the successful candidate.

The number of men employed is about 600. The Works are engaged mainly on the overhaul and repair of electrical and mechanical coal mining plant and machinery.

Candidates should have a general engineering background and preferably have some knowledge and experience of mining plant and equipment. They must be conversant with the repair of wagons to main-line standard. Experience in the heavy repair of steam and diesel locomotives is essential. Candidates must have a knowledge of iron and brass foundry technique. The post requires a person capable of supervising the overall working and administration of the Shops to achieve and sustain the maximum throughput of planned overhaul and jobbing work and of maintaining the required standards of workmanship and good personnel relationships. The possession of a Higher National Certificate in Mechanical and/or Electrical Engineering or equivalent is essential.

Applicants should reply within 7 days quoting SG/290/5(78) and giving full details of age, education, qualifications and experience to N.C.B., 7 Side, Newcastle upon Tyne, 1. E5144

WHITTINGTON HOSPITAL, LONDON, N.19

SENIOR ENGINEER

SENIOR ENGINEER required. The successful candidate will be responsible to the Superintendent Engineer for the maintenance and operation of the engineering services of one wing of the Hospital.

Applicants must have completed an apprenticeship in mechanical engineering and had experience in a supervisory position. They must possess a Ministry of Transport Higher National Certificate or other recognised qualification in Mechanical or Electrical Engineering. Salary within the scale £680–£815 per annum, plus London Weighting. The post is a resident one and accommodation is available for which a charge, at present £96 per annum, is payable.

Application forms obtainable from and returnable to Group Secretary, Archway Group, H.M.C., 46, Cholmeley Park, N.6 (ARC 3070, Ext. 526/527), by 26th March. E5157

TRAINING OFFICER

for

WINDSCALE AND CALDER WORKS

to be responsible to the Training Manager for lecturing on engineering and other subjects ranging from elementary introductory talks to detailed descriptions of engineering techniques. Some training administration will be involved.

A recognised engineering apprenticeship and corporate membership of a senior engineering institution, or equivalent, are essential. Experience in teaching or industrial training is desirable. Knowledge of atomic energy is not essential as training will be given where necessary.

Salary between £845 (at age 25) and £1315.

Contributory Superannuation. Staff housing scheme.

Send postcard for application form, quoting reference 2975/J.1 to Works Secretary, UNITED KINGDOM ATOMIC ENERGY AUTHORITY, INDUSTRIAL GROUP, Windscale and Calder Works, Sellafield, Seascale, Cumberland.

Closing Date : 23rd March, 1959.

E5114

TENDERS

SCOTTISH HOME DEPARTMENT

LONDON-CARLISLE-GLASGOW-INVERNESS TRUNK ROAD A.74, BIRKWOOD DIVERSION, LANARKSHIRE

The existing bridge over the Birkwood Burn at Blackwood, Lanarkshire, is to be replaced by a short by-pass comprising the CONSTRUCTION of a large REINFORCED CONCRETE CULVERT, HIGH EARTH EMBANKMENT and approximately ONE-THIRD OF A MILE OF NEW ROAD.

TENDERS for this are invited from contractors with appropriate experience and with substantial resources of earth moving equipment. 220,000 cubic yards of filling are to be placed within a period of four months.

Contract documents and drawings obtainable from Messrs. Babtie, Shaw and Morton, Chartered Civil Engineers, 17, Blythswood Square, Glasgow, C.2, upon payment of a deposit of £15 by cheque made payable to the Order of the Queen's and Lord Treasurer's Remembrancer. The deposit will be returned if a bona fide Tender is submitted and not subsequently withdrawn.

Tenders on the official form, which must be received before 4 p.m. on Tuesday, 31st March, 1959, should be sent in a sealed registered envelope marked "Birkwood Diversion," addressed to the Secretary, Scottish Home Department, Broomhouse Drive, Saughton, Edinburgh, 11.

The Secretary of State does not bind himself to accept the lowest or any Tender. E5130

DUNMOW RURAL DISTRICT COUNCIL

GREAT EASTON AND DUTON HILL

SEWERAGE EXTENSIONS

CONTRACT NO. 15

TENDERS are invited on a fixed price basis in accordance with the Ministry of Housing and Local Government Circular No. 31/57, for the CONSTRUCTION of SEWERAGE EXTENSIONS at Great Easton and Duton Hill.

The sewerage comprises in all the laying of about 5000 linear yards of 6 inch diameter S.G.W. sewer, together with 4 inch and 6 inch diameter S.G.W. house connections and construction of 11 brick and 37 precast concrete manholes.

General conditions of contract, specification, bill of quantities and drawings may be obtained from the Council's Consulting Engineers, Messrs. J. D. and D. M. Watson, MM.I.C.E., 67, Tufton Street, Westminster, S.W.1, on and after 9th March, 1959, on payment of a deposit of ten guineas refundable only to Contractors who submit bona fide Tenders and return all documents and drawings. Deposit cheques should be made payable to Dunmow Rural District Council.

The Council do not bind themselves to accept the lowest or any Tender.

Tenders must be returned in envelopes which do not bear any name or mark indicating the sender, endorsed "Tender for Sewerage Contract 15," and delivered at the office of the undersigned by noon on 17th April, 1959.

A. H. BURTON,
Clerk of the Council.

Council Offices,
Dunmow,
Essex. E5103

BRISTOL AVON RIVER BOARD

CIVIL ENGINEERING WORKS AT MELKSHAM, WILTS

CONTRACT NO. 192

The Bristol Avon River Board invite TENDERS for CIVIL ENGINEERING WORKS at Melksham, Wilts.

The works comprise the construction of a sluiceway for a 30ft. by 11ft. 3in. automatic roller sluicegate, together with a weir and fish pass approximating 50ft. in width, the driving of steel sheet piling, excavation and ancillary works.

Applications for copies of the specification, bill of quantities, conditions of contract and contract drawings should be made to the undersigned.

Tenders, duly sealed and endorsed "Contract No. 192," must be delivered to the Clerk of the Bristol Avon River Board at 18, Bennett Street, Bath, not later than noon on Friday, April 17th, 1959.

F. GREENHALGH,
Engineer to the Board.

18, Bennett Street,
Bath.
March, 1959. E5131

INDIA STORE DEPARTMENT

The Director General of India Store Department, Government Building, Bromyard Avenue, Acton, London, W.3, invites TENDERS for the SUPPLY of :—

	Quantity Tons
MILD STEEL SHEETS COLD ROLLED deep drawing quality to B.S.S. 1449 of 1956 (EN.2A).	1000

Forms of Tender may be obtained from the above address on or after the 13th March, 1959, at a fee of 10s., which is not returnable. If payment is made by cheque, it should please be made payable to "High Commission of India." Tenders must send their Tenders so as to reach this office latest by 1 p.m. on Thursday, the 16th April, 1959.

Please quote Reference No. 40/58/RLY. E5169

EDUCATIONAL

UNIVERSITY OF CAMBRIDGE

DEPARTMENT OF ENGINEERING

POST-GRADUATE COURSE IN STRUCTURES AND MATERIALS

The 1959–60 Post-Graduate Course in Theory of Structures and Strength of Materials will be held in the Department of Engineering, Cambridge University, beginning on 6th October, 1959 and finishing in June, 1960.

The latest advances made in the understanding of the behaviour of metallic structures under static, repeated or fatigue loading will be the principal subject of the course, with particular emphasis on welding as a method of fabrication. No attempt will be made to teach conventional methods of design, but present-day practice and possible future developments will form the subject of critical study.

The object of the course is not to train research workers, but to help engineers to apply the latest advances in knowledge. The course will include lectures, colloquia and laboratory work, and each student will be encouraged to make a detailed study of some problem of particular interest to him.

The course is open to university graduates with industrial experience, and to others with suitable equivalent qualifications and of sufficient experience to obtain full benefit from a post-graduate course.

Further details and forms of application for admission may be obtained from the Secretary, Cambridge University Engineering Laboratory, Trumpington Street, Cambridge. The completed forms of application should be returned to the Secretary not later than 31st May, 1959. E5120 E

UNIVERSITY OF CAMBRIDGE

DEPARTMENT OF ENGINEERING

POSTGRADUATE COURSE IN CONTROL ENGINEERING

The 1959–60 Postgraduate Course in Control Engineering will begin on 6th October, 1959, and will last approximately nine months. This is the fifth course of a series which has been established in order to meet the need of Industry for men trained to a high standard in the theoretical principles and practical application of automatic control and to afford opportunity for study of advanced techniques and modern development in the general field of Control Engineering.

The number of students will be limited and applications must reach the Secretary of the Department not later than 1st July, 1959. Candidates should hold a degree in Engineering or a suitable alternative qualification and have had some practical training and experience. They will be required to attend for interview in Cambridge on or before 15th August, 1959.

Further details and forms of application for admission may be obtained from the Secretary, Cambridge University Department of Engineering, Trumpington Street, Cambridge. E5145 E

UNIVERSITY OF BIRMINGHAM

DEPARTMENT OF MECHANICAL ENGINEERING

GRADUATE SCHOOL OF THERMODYNAMICS AND RELATED STUDIES

A course available in the above School provides facilities for the study, at advanced level, of modern developments in Thermodynamics and allied subjects and of their applications in the general field of the heat engine. The normal entrance qualifications are an Honours Degree in Mechanical Engineering together with a minimum of two years of practical experience in industry. In special circumstances applications may be considered from graduates in other Sciences. On completion of the twelve-month course commencing on 5th October, 1959, and including a minimum of nine months' attendance at the University, successful candidates qualify for the award of the degree of Master of Science.

Further particulars of this course and of available scholarships, together with the appropriate forms of application for admission, may be obtained from the Deputy Registrar, The University, Birmingham, 15. E5163 E

UNIVERSITY OF MANCHESTER

A FULL-TIME COURSE of POST-GRADUATE LECTURES on the ADVANCED THEORY OF STRUCTURES will be held in the University of Manchester between July 6th and 18th, 1959.

The Lectures are intended for Engineers, Lecturers and Research Workers who wish to study and discuss recent work in the subject. The lecturers will be Professor J. A. L. Matheson and Dr. J. F. Gibson, of the University of Manchester ; Dr. N. W. Murray, of the University of Sheffield, and Dr. R. K. Livesley of Cambridge. The topics to be covered include the general theory of hyperstatic structures ; stability of frameworks, matrix analysis of structures ; the use of computing machines for frameworks and shells.

The fee for the lecture course is £15.

Accommodation for those requiring it will be arranged at one of the University's Halls of Residence.

Further particulars may be obtained from the Registrar, The University, Manchester, 13. E9849 E

IMPERIAL COLLEGE

A THREE-WEEK COURSE on PLASTICITY OF PRODUCTION PROCESSES will be held from April 20th. The most important technological theories and researches underlying the major metal-working and machining processes will be considered. —Further information from the Registrar, Imperial College, London, S.W.7. E5113 E

Classified Advts. continued on page 116

INSTRUMENT TECHNICIANS

are required at the Atomic Energy Research Establishment HARWELL :

Post 1 (Instrument W.S Foreman), responsible for repair and modification of a wide range of mechanical, electrical and electronic industrial and laboratory instruments.

Post 2 involves responsibility to the Instrument Engineer for the commissioning and maintenance of process instrumentation and control equipment of experimental plant and to a Senior Foreman for a small instrument workshop and fault-finding work.

For both posts an engineering apprenticeship or equivalent training, practical experience in electrical and mechanical instrument repair work and sound technical knowledge (O.N.C. standard) are essential.

Salary £905–£1085.

Housing and superannuation schemes.

Please send a POST CARD to the Group Recruitment Officer (1332/25), *U.K.A.E.A., A.E.R.E., Harwell, Berks., for details.*

E5162

EDUCATIONAL

UNIVERSITY OF MANCHESTER

A FULL-TIME COURSE OF POST-GRADUATE LECTURES on the ADVANCED THEORY OF STRUCTURES will be held in the University of Manchester between July 6th and 18th, 1959.

The Lectures are intended for Engineers, Lecturers and Research workers who wish to study and discuss recent work in the subject. The lecturers will be Professor J. A. L. Matheson and Dr. J. E. Gibson, of the University of Manchester; Dr. N. W. Murray, of the University of Sheffield, and Dr. R. K. Linsley, of Cambridge. The topics to be covered include the general theory of hyperstatic structures; stability of frameworks, matrix analysis of structures; the use of computing machines for frameworks and shells.

The fee for the lecture course is £15.

Accommodation for those requiring it will be arranged at one of the University's Halls of Residence.

Further particulars may be obtained from the Registrar, The University, Manchester, 13. E9849 E

A.M.I.MECH.E., B.Sc., City and Guilds, &c. Guarantee Postal Courses for all Exams. and Technical Divisions from Elementary to Degree standard including Automation Techniques. Approximately 95 per cent successes. 148-page prospectus free on request.—B.I.E.T. (Dept. 22), 29, Wright's Lane, London, W.8. E114 E

AUTOMATION.—AUTHORITATIVE COURSES are now available in Digital and Analogue Computer Technology, Applied Electronics, Data Processing and Instrumentation up to professional level by home study. Individual enrolment or industrial group scheme enrolments accepted. Syllabuses and prospectus sent on request.—Write (Dept. S.E.8), E.M.I. Institute School of Electronics, College House, Kensington, London, W.8. E145 E

SITUATIONS VACANT

APPLICANTS ARE ADVISED TO SEND COPIES, NOT ORIGINALS, OF THEIR TESTIMONIALS UNLESS OTHERWISE REQUESTED.

A TECHNICAL SERVICE ENGINEER is required by Dresser (Great Britain), Ltd., Clark Bros. Co. Division. This Division is responsible to the United States Parent Company for the marketing of gas engines, motor-driven reciprocating compressors, centrifugal compressors and gas turbines, manufactured under licence in the United Kingdom and on the Continent. Candidates should be well qualified Graduate Mechanical Engineers, aged 28–35. The company is a well-established European organisation and offers good pay and conditions, with a pension scheme. There are excellent prospects for early advancement to full sales engineering responsibilities.—Apply, with full personal particulars and details of experience and previous appointments, to Dresser (Great Britain), Ltd., Clark Bros. Co. Division, 197, Knightsbridge, London, S.W.7. E2323 A

ASSISTANT REQUIRED for small Engineering Department, aged 21–23. Candidates must have some Drawing-Office experience, and those with O.N.C. in mechanical engineering and knowledge of hydraulics will be given preference.—Apply in writing with full particulars, salary expected, to Secretary, E. P. Barrus, Ltd., 12–16, Brunel Road, W.3. E2326 A

DESIGN DRAUGHTSMAN

A Heavy Engineering Company on Merseyside invites applications from Design Draughtsmen of proved ability and experience in Mechanical Handling Equipment, especially Aerial Ropeways on both Mono and Bi-cable systems, for a senior position on the design staff. A good starting salary is offered commensurate with experience, together with a generous pension scheme and excellent opportunities for promotion.—BOX X.22, Lee & Nightingale, Liverpool.

E5129 A

DESIGN/DRAUGHTSMEN

Applications are invited from men under 40 years of age who were apprentice trained and hold H.N.C. or equivalent, to fill vacancies in the following D.O. Sections :—

1. MECHANICAL : experience required in general mechanical design and installation, preferably of medium to heavy industrial process plant.
2. ELECTRICAL : good all-round experience desired in the installation of the electrical plant and services of a large factory.
3. WORKS SERVICES (Steam, Water and Air) : for this good experience of problems involving industrial steam applications, piping and pumping systems is essential, and an H.N.C. endorsement for Heat Engines, Applied Thermodynamics or Steam Engineering is desirable.

All appointments are permanent and pensionable ; five-day, 40-hour week ; 3 weeks' annual holiday ; good working conditions. Assistance with housing given when necessary and pending removal a tax-free allowance of £4 per week is given to married men. Company pays cost removal.

Please write to SP.A Dept., MICHELIN TYRE CO., LTD., STOKE-ON-TRENT, STAFFS, quoting ref. B/E.

E5105 A

ASSISTANT SURVEYORS required for work at home and overseas having some experience in the survey and profiling of routes for Overhead Transmission Lines. Pension Fund.—Apply in writing to Personnel Officer (Staff), BRITISH INSULATED CALLENDER'S CONSTRUCTION COMPANY, LTD., 21, Bloomsbury Street, London, W.C.1. E5121 A

DEPUTY WORKS MANAGER

An old-established company of electro-mechanical engineers have a vacancy for a Deputy Works Manager, age about 30–35, with a proved background and experience that fits him for possible promotion to the position of Works Manager on the retirement of the present manager.

Applicants should be of A.M.I.Mech.E. standard, and, in addition to having sound machine shop experience on short run production, should possess a good knowledge of modern management techniques, including works study, shop planning and loading and piecework systems.

The position carries a non-contributory pension scheme of liberal proportions.

Please send full details, including salary requirements, to BOX No. E5141, "The Engineer."

A

DESIGNER-DRAUGHTSMAN, experienced in structures and mechanical handling (required by a progressive firm in the Tyneside area). Commencing salary in the range of £980 per annum, paid overtime and pension scheme in operation.—BOX No. E2311, "The Engineer." A

DESIGNER-DRAUGHTSMAN (MECHANICAL) required for Research and Development Team engaged on interesting development work in connection with special structures and diesel- and steam-operated plant. Minimum qualifications H.N.C. Age group 24–30 years. The appointment is permanent and progressive in an expanding organisation. Contributory Pension Scheme and good canteen facilities. Salary in accordance with age, qualifications and experience. The works are situated 15 (fifteen) minutes 'bus journey from the centre of Ipswich.—Applications to Personnel Officer, The British Steel Piling Company, Ltd., Claydon, Suffolk. E5011 A

DESIGNER-DRAUGHTSMAN REQUIRED for design of special purpose plant. Applicants should have practical background and several years' experience of machine design. Electrical knowledge an advantage. Work involves development of plant for rubber and plastics production. Interesting, varied work, requiring initiative and responsibility. Age group 35–50. Contributory pension scheme. —Applications to Equipment Engineer, SEMTEX LIMITED, BRYNMAWR, South Wales. E5061 A

DRAUGHTSMAN

required to lead section of drawing-office, concerned with all types of light structural work. Must be a qualified designer and experienced in detailing site measurements and levelling.

Write, stating age, apprenticeship, qualifications and experience, to :

Personnel Manager,
FREDK. BRABY AND CO., LTD.,
Crayford, Kent,
quoting ref. S.E.6.

E5151 A

EDITOR REQUIRED for established marine journal, with a sound knowledge of the shipbuilding and ancillary industries. Non-contributory pension scheme. Only top class men should apply with full particulars of experience, age and salary required.—BOX 0370, c/o Jackson's, 54, Old Broad Street, E.C.2. E5092 A

ENGINEER/DRAUGHTSMAN REQUIRED for general mechanical engineering and engine gearbox design. Good all-round man wanted. Pension scheme.—Write, stating salary required, age and experience to FAIREY MARINE, LTD., Hamble, Hants. E5073 A

ENGINEER SURVEYOR required for inspection of Boiler and Pressure Plant. Must have 1st Class M.O.T. Certificate with Steam Endorsement or equivalent. Salary £735 to £1060 (ESA Scale), other benefits. Resident in or near Sheffield.—Apply Eng. Dept., GENERAL ASSURANCE CORP., LTD., 99, Aldwych, London, W.C.2. E5122 A

ESTIMATOR required by PETER LIND AND CO., LTD., Romney House, Tufton Street, Westminster, S.W.1. Experienced in estimating for Civil Engineering and Reinforced Concrete work.—Apply in writing, giving age, experience and salary required. E5066 A

FINE MECHANISMS

ASSISTANT MANAGER is required by a large Midland Company for a department employing 30 men and women engaged in the production of small highly accurate components. Applicants should have had basic training in small tool making and, if possible, possess some knowledge of metallurgy and heat treatment. Initiative and a wide experience of methods of manufacture are required, with a view to the possible mechanisation of some of the skills involved. H.N.C. desirable. Successful candidate may expect to succeed present Manager on retirement in a few years' time. Applicants should reply, giving full details of education and experience.—BOX No. E5109, "The Engineer." A

GENERAL ENGINEERING DRAUGHTSMAN (Senior) having experience in machine design and works layouts. A knowledge of works building design desirable but not essential. Technical education to at least O.N.C. Some assistance will be given with regard to house purchase in cases of successful applicants who are married.—Write, giving details of experience and stating age and present salary to the Personnel Manager, Ferodo, Ltd., Chapel-en-le-Frith, via Stockport. E5098 A

HEAD ESTIMATOR required after Easter by established and steadily expanding medium weight weld-fabricating engineers in the Home Counties. Good salary with house to man with right experience. Applicants can only be considered who give in their own handwriting full details of career to date, including exact description of classes of work, present employer, and salary.—BOX No. E2307, "The Engineer." A

INSTALLATION DESIGN DRAUGHTSMEN required for varied and interesting assignments on traction, marine and industrial Diesel engines, having a sound engineering background and some experience, possessing at least O.N.C., preferably H.N.C. Excellent prospects for enthusiastic and capable designers. Pleasant locality : excellent Staff Service conditions, Superannuation and supplementary non-contributory pension scheme, welfare, canteen and sports facilities.—Apply, stating age, experience, qualifications and present salary to Personnel Manager, Davey, Paxman and Co., Ltd., Standard Ironworks, Colchester, Essex. E5159 A

JUNIOR DRAUGHTSMAN required for Works Engineer's Department of large Coventry engineering company, for work in connection with industrial buildings and factory services. Some knowledge of heating and ventilation would be an advantage, but is not essential.—Reply, stating age, experience and salary expected to Ref. JD, BOX No. E5123, "The Engineer." A

MANAGER

West Riding Engineering Company requires MANAGER for its Flexible Shaft Coupling Department. Applications are invited from Degree or Chartered Mechanical Engineers, preferably not above 45 years of age, with sound design and sales experience. Salary range £1500–£1750.—Write, giving full details, to Managing Director, BOX No. E2314, "The Engineer." A

MECHANICAL ENGINEER—GRADUATE—required by manufacturers of industrial sewing machines. Adequate experience in the methods department of some large metal-working factory and conversant with production methods, tooling, latest equipment, &c. Age bracket 30–40. Pension and life assurance scheme in operation. Please write, giving full details and salary required, to Managing Director.—BOX No. E5179, "The Engineer." A

MECHANICAL ENGINEER, degree or A.M.I.Mech.E., to be responsible for design and technical sales of power transmission developments, particularly couplings. Competency as a design and development engineer matched with personality and enthusiasm are essential. This is a senior appointment with commensurate salary. Excellent Life Assurance and Pension Scheme in operation. Location : Leicestershire. Write fully about your education and career in strict confidence.—BOX No. E5033, "The Engineer." A

ROBERT M. DOUGLAS (CONTRACTORS) LTD.,
require
QUANTITY SURVEYORS in the Midlands and South Wales for building and civil engineering works, including motorways and bridges. Must be contractor trained. Good prospects, pension scheme.—Apply in writing, stating age, qualifications and experience, to 395, George Road, Birmingham. E5153 A

SALES ENGINEER, experienced in Materials Handling Equipment, required by large, progressive company in the Reading area, to expand the sales of Automatic Mechanical Handling Plant. All replies will be treated in the strictest confidence, and applicants should give full details of sales and engineering experience, together with salary anticipated.—BOX No. E5132, "The Engineer." A

SENIOR DESIGN DRAUGHTSMAN required for interesting work on mechanical engineering projects. Knowledge of hydraulics an advantage.—CHAMBERLAIN INDUSTRIES, LTD., Staffa Road, Leyton, E.10. (LEY 3678). E5094 A

SENIOR DRAUGHTSMEN required for interesting work on marine gearing. Applicants should preferably have served full apprenticeship and had several years' diesel or gearing drawing-office experience.—Apply, Technical Manager, MODERN WHEEL DRIVE, LTD., Lindo Lodge, Stanley Avenue, Chesham, Bucks. Tel.: Chesham 8000. E5180 A

TECHNICAL ASSISTANT required, with experience of initial design calculations and subsequent testing of aircraft and commercial heat exchangers. H.N.C. or above. Write, stating age, experience and salary required.—BOX No. E5128, "The Engineer." A

THE REED PAPER GROUP

have a vacancy for an experienced

INSTRUMENT ENGINEER

in their Instrument Department at Aylesford Paper Mills, Nr. Maidstone.

Candidates should have wide experience in installation and maintenance of pneumatic, electronic and hydraulic process control equipment.

Good salary and prospects, non-contributory pension scheme, &c.

Apply, with full particulars of age and experience, to :

Personnel Manager,
AYLESFORD PAPER MILLS,
Larkfield,
Nr. Maidstone, Kent.

E5152 A

THE BRITISH STEEL PILING CO., LTD., require a CIVIL ENGINEERING ASSISTANT, aged about 25 to 30, for their London office. The work will involve the design of steel sheet pile retaining walls for all types of civil engineering structures, as well as cofferdams and bearing pile foundations. An Engineering Degree or equivalent qualifications are required. Previous experience of steel piling and soil mechanics is not essential, though desirable.—Apply in writing only, giving details of qualifications and experience, and stating age and salary required, to the Company at 10, Haymarket, S.W.1, marking the envelope "Civil Engineering Assistant." E5176 A

TECHNICAL EDITOR required by rapidly expanding organisation in the East Midlands. This appointment carries an excellent starting salary and offers considerable scope for development to a man with ability, energy and a wide knowledge of production and mechanical engineering. Excellent superannuation scheme and pleasant surroundings. Send details of career and present salary.—BOX No. E5134, "The Engineer." A

TRANSLATORS REQUIRED for translation of technical periodicals, books, &c., from and into Russian, German, French, Italian, &c. Sound knowledge of mechanical or production engineering essential. These are key positions in a rapidly expanding organisation in the East Midlands, with excellent prospects of advancement, working conditions and superannuation scheme.—Send full details to the Secretary, PRODUCTION ENGINEERING RESEARCH ASSOCIATION, Melton Mowbray, Leics. E5133 A

WALKER BROTHERS (WIGAN), LTD.—a progressive firm engaged in the manufacture of paper and board-making machinery have vacancies for EXPERIENCED MECHANICAL ENGINEERING DRAUGHTSMEN—preferably with H.N.C. Superannuation fund, canteen and welfare facilities.—Applications, stating age, experience, &c., to the Personnel Manager, Pagefield Iron Works, Wigan. E5137 A

JOSEPH LUCAS
LIMITED

Manufacturers of Aircraft and Motor Equipment, require

FULLY EXPERIENCED
DESIGNERS

Preference will be given to applicants who are conversant with gas turbine combustion equipment or have experience of heat exchangers, ventilating practice, fans and oil firing equipment. Consideration will also be given to persons with good mechanical experience who could quickly adapt themselves to a wide range of products requiring initiative and drive. It is essential that applicants should hold the Higher National Certificate or possess similar qualifications. This is a well-paid position offering excellent chances of promotion. A generous Pension Scheme is in operation.

Apply NOW to the Personnel Manager, Hargher Clough Works, Burnley.

E5124 A

CHIEF ESTIMATING ENGINEER

Required immediately by expanding Company in the steel equipment industry situated in North London. Applicants should have had experience in the Sheet Metal Industry, be capable of controlling staff and have a thorough knowledge of Estimating.

Experience of Costing procedures and Process Planning an advantage. The appointment carries an excellent salary and a pension scheme is in force.

Only those giving full details of experience, age and salaries earned, etc., will be considered.

Write to BOX No. E5148, "The Engineer."

A

PROJECT ENGINEER

PLASTIC AND RUBBER EXTRUSION ENGINEER required by nationally known Engineering Company in Manchester. This senior post calls for experience in the design of Rubber and Plastic Extruders and their ancillary gear, i.e. let-offs and take-ups for all applications in Rubber and Plastic extrusions. The applicants should have initiative and a high degree of responsibility, a University Degree or equivalent. He will be required to meet customers and discuss their problems with a view to getting out the necessary designs and drawing up of specifications.

The post has a non-contributory Pension and Life Insurance Scheme.

All applications will be treated in the strictest confidence.

Write in the first instance to the Personnel Manager, BOX No. E5164, "The Engineer."

A

SITUATIONS VACANT

MECHANICAL ENGINEER

W. H. Allen Sons & Company Limited, Bedford, require a Senior Mechanical Design Engineer for their Servomechanisms and Control Systems Design Department. Applicants should have a good Degree in Mechanical Engineering and Graduate or Corporate Membership of the I.Mech.E. The preferred age range is 27 to 35.
The successful candidate will be responsible for design and development work involving control theory as applied to hydraulic-mechanical systems, including, for example, high-performance prime-mover governing. He will be expected to co-operate with other staff on projects involving the use of electro-mechanical and electronic devices. There is a well-equipped departmental laboratory.
An excellent pension scheme is in operation and assistance with removal expenses will be given.
Applications should be sent to the Personnel Manager, quoting full details of education, qualifications and experience, and stating age and present salary.

E5095 A

SITUATIONS VACANT

E·A·L

EXECUTIVE APPOINTMENTS LIMITED

A leading manufacturer of plastic packaging products seeks a

PRODUCTION MANAGER

to develop production at the main factory in S. London. Duties will include contract costing, engineering services, works personnel and technical advice.
This post offers challenge and scope to man aged 30-40 with professional engineering qualifications and responsible production executive experience. Machine shop and tool room experience and service in plastics industry essential. Starting salary not less than £1600.

Write briefly and in strictest confidence, quoting case number RW25
The Managing Director

EXECUTIVE APPOINTMENTS LIMITED

78, Wigmore Street, London, W.1.

E5117 A

SITUATIONS VACANT

Richard Thomas and Baldwins Limited

require a

LOCOMOTIVE SUPERINTENDENT

at their integrated iron and steelworks

at Ebbw Vale, Mon.

This appointment involves the administration and practical control of a maintenance and repair department servicing a fleet of 40 steam and diesel locomotives. It offers a promising opportunity to a keen and capable organiser with a first-class knowledge of modern methods of maintenance.

Applicants, who should be under 40 years of age, must have been educated to H.N.C. standard and have had practical experience of diesel engines.

Salary according to qualifications ; superannuation scheme.

Applications should be addressed to the
Chief Engineer,
Richard Thomas and Baldwins, Ltd.,
Ebbw Vale,
Mon.

E5150 A

SITUATIONS VACANT

MECHANICAL ENGINEER or METALLURGIST

is required by the Mobil Oil Company Limited at Coryton Refinery. The position is in the Inspection Section of the Engineering Division and entails the inspection of fired heaters, boilers, pressure vessels, heat exchangers, etc.

Applicants should :—
(a) hold a mechanical engineering or metallurgy degree and have served a graduate apprenticeship.
or (b) have served a full engineering apprenticeship and hold a Higher National Certificate, preferably with the necessary endorsements for Grad.I.Mech.E.
and (c) have had experience in industry, preferably oil, chemical or sea-going experience.
Four-figure starting salary.
Modern housing available.
Excellent Employee Benefit Plans.

Applications should be addressed to :—
Employee Relations Superintendent,
MOBIL OIL COMPANY LIMITED,
Coryton Refinery,
Stanford-le-Hope, Essex.

E5135 A

CIBA (A.R.L.) LIMITED

(manufacturers of synthetic resins)

wish to appoint

A MECHANICAL TEST ENGINEER

to work in the Structures Laboratory of their bonded structures division.

Candidates should preferably :

(*a*) be aged between 22 and 26,
(*b*) have an H.N.C. or equivalent qualification in Mechanical Engineering,
(*c*) have at least two years' testing experience.

This is a new appointment and provides an opportunity both to join an expanding organisation and gain increased experience and responsibility.

Those interested will find conditions excellent, and the salary payable will be discussed at an interview. Letters of application setting out all relevant information and stating present salary should be sent to CIBA (A.R.L.), LIMITED, Duxford, Cambridge.

E5154 A

SENIOR TECHNICAL ENGINEER

A major Industrial Group has a vacancy for a Senior Technical Engineer to work in the Technical Department at their Head Office situated in London.

The work is in connection with the investigation and development of new techniques and the efficiency of existing techniques.

This is a senior appointment and is an exceptional opportunity for a person with a good Honours Degree in Mechanical Engineering coupled with a good practical background. The successful applicant must have a good personality and he must feel that he would be able to accept responsibility in the field of Technical Management later on. Age range 30/33 years.

Apply, stating full details of age, qualifications and experience.—BOX No. E5115, "The Engineer."

A

FORD MOTOR COMPANY LIMITED

requires a

PATENTS ENGINEER

This position calls for first class experience in patent work in the engineering field and an engineering qualification, either a degree or H.N.C. Experience of patent work relative to automobile engineering and a knowledge of French and German will be an advantage. Preferred age range 30–35.

The position is permanent and progressive, and carries with it participation in a non-contributory pension scheme.—Applicants should write to Training and Recruitment Department (O12A), Ford Motor Company, Ltd., Dagenham, Essex, giving details of age, experience and qualifications and quoting reference VPE.

E5160 A

BRITISH OXYGEN ENGINEERING LTD.

invite applications for

DEVELOPMENT ENGINEERS

to join a team engaged in development work of Plants operating at Low Temperature.

This new field of endeavour offers considerable scope to engineers with a good Degree or equivalent and who have experience in the design of various types of compressors, heat exchangers and pressure vessels.

The Company offers excellent conditions of service and pursues a progressive salary policy. Assistance with housing may also be given.

Applications in writing, giving age, qualifications, experience and present salary, should be addressed to :—

Employment Officer (E/G. 4523),
BRITISH OXYGEN ENGINEERING, LTD.,
Angel Road, Edmonton, N.18.

E5156 A

ENGINEERING IN THE PLASTICS INDUSTRY

To assist in a programme of development the PLASTICS DIVISION OF
IMPERIAL CHEMICAL INDUSTRIES LIMITED
require immediately

MECHANICAL AND CHEMICAL ENGINEERS

for deployment over

DESIGN
WORK STUDY

RESEARCH AND DEVELOPMENT
WORKS MANAGEMENT

Whilst there is a need to add to the engineering staffs now working on established products, we also want men for projects essentially novel in character leading to manufacture in fresh fields.
For all these appointments we need not only technically well-qualified men, but those with the attributes of versatility, drive and a progressive attitude so vital to a forward looking industry.
Applications are invited from men holding First or Second class honours degrees in Mechanical or Chemical Engineering with some years of industrial experience ; in addition we should be glad to hear from those graduating this year, who are free from National Service and who have served a recognised apprenticeship.
There are excellent conditions of service and prospects and Pension and Profit-sharing schemes are in operation. As a means of helping married men to establish themselves in our location, some assistance can be given towards house purchase, reasonable removal claims are met, and lodging allowances are also available.

Apply briefly to the Staff Manager,
Imperial Chemical Industries Limited,
Plastics Division,
Black Fan Road, Welwyn Garden City, Hertfordshire

E5136 A

MSL

have been retained to advise on the appointment of a

CHIEF PRODUCTION ENGINEER

for an old-established public company in London engaged in specialised light engineering and process industry. He will be the Deputy Manager of a department of about 30 specialists and will be the chief adviser of the parent company and its subsidiaries on all production engineering problems, including machine design, work study, production planning and control.

Candidates aged between 35 and 45 must have an engineering degree or equivalent qualification. They should have several years' experience as works managers (or assistants) or senior production engineers in light engineering. Experience as management consultant would be a definite advantage.

Initial salary in range £2,000–£3,000, according to qualifications and experience : contributory pension.

No information will be disclosed to our clients until candidates know their identity and have given permission after personal discussion. Please send brief details in confidence, quoting reference G.1413, to D. M. Sidney.

MANAGEMENT SELECTION LIMITED
17, Stratton Street, London, W.1.

E134 A

SUB-CONTRACTING

CASTINGS.—We can save your porous castings, ferrous or non-ferrous, by an approved impregnation process ; sample castings treated ; A.I.D. approved. —Recupero, Ltd., 66, South Harrow Viaduct, Harrow, Middlesex ('Phone Byron 1178). E109 MW

KELLERING AND CAM PROFILING capacity up to 8ft. by 6ft. or 6ft. diameter.—ARMYTAGE BROS. (KNOTTINGLEY), Ltd., The Foundry, Knottingley, Yorkshire (Telephone : Knottingley 2743/4). E116 MW

PRATCHITT BROTHERS, LTD., Denton Iron Works, Carlisle, having well-equipped engineering shops and ironfoundry, invite enquiries for General Engineering, Structural and Platework, from firms wishing to have plant made to their own designs and specifications. E751 MW

FOR HIRE

LATTICE STEEL. Erection Masts (light and heavy), 30ft. to 150ft. high, for immediate hire.—Bellman's, 21, Hobart House, Grosvenor Place, S.W.1. ('Phone, SLOane 5259). E103 K

MACHINERY Etc. WANTED

BLACKBURN & DISTRICT HOSPITAL MANAGEMENT COMMITTEE
WANTED

Second-hand TURBINE-DRIVEN HOT WATER CIRCULATING PUMPS. Turbine, single-stage ; steam pressure, 100 p.s.i., exhaust pressure, 5 p.s.i. ; governor controlled.
PUMP, Worthington or similar, 6in. suction, 5in. delivery, capable of 400 galls./min. Driven through vee belts or flexible coupling, all mounted on bed plate.
Prices and permission to view to the Superintendent Engineer, Queens Park Hospital, Haslingden Road, Blackburn, Lancs.

E5177 F

WANTED IMMEDIATELY, 600 h.p. vertical Steam Engine for saturated steam at 120 p.s.i., exhausting to 15 lb. back pressure.—BOX No. E5146, "The Engineer." F

URGENTLY REQUIRED : Motor-driven Two High Cold Rolling Mill with rolls approximately 12in. diameter by 20in. wide, complete with variable speed motor drive suitable for either a.c. or d.c. Please forward full details and where the plant can be inspected.
GEORGE COHEN SONS AND CO. LTD.
(HYDRAULIC DEPT),
STANNINGLEY, Nr. LEEDS.

E5175 F

Classified Advts. continued on page 118

BUSINESSES and PREMISES

SOUTH AFRICA

Owner of private Engineering Company wishes to sell well-equipped concern in a large City in Southern Africa.

The Company is in a satisfactory financial position and is a rare opportunity for a British concern to acquire a ready-made and established business in Africa.

Full details upon application with Bankers' and Auditors' Reports to Principals only.—BOX No. E5155, "The Engineer."

E

FOR SALE

600

FOUR skid-mounted, 132kVA. ROLLS-ROYCE 380/400 volts, 3-phase, 50-cycles, self-contained DIESEL - ENGINE - DRIVEN ALTERNATOR SETS, housed in sheet steel enclosure. Engine is radiator fan cooled and arranged for electric starting, and is direct coupled at 1500 r.p.m. to alternator by MACFARLANE. Each complete with switchboard.

GEORGE COHEN,

SONS AND CO. LTD.
WOOD LANE, LONDON, W.12.
Tel.: Shepherds Bush 2070.

E204 G

FOR SALE

FRORIEP 54in. Heavy-Duty Vertical TURNING AND BORING MILLS, fitted with side head; main motor 50 h.p. New 1952. In first-class condition.

F. J. EDWARDS, LTD.,

359–361, EUSTON ROAD,
LONDON, N.W.1.
EUSton 4681 and 3771.

E5112 G

OFFERS ARE INVITED FOR THE FOLLOWING, which may be inspected at Clifton Hospital, York, at any time during normal working hours:
BRADFORD WASHING MACHINE, 78in. by 36in. (1931), belt-driven.
WATSON-LAIDLOW HYDRO-EXTRACTOR, 36in. independent electric drive, 400V, 3-phase, a.c.
HODGKINSON HIGH-RAM COKING STOKERS (pair), suitable for Lancashire Boiler with 38in. furnaces, 4ft. 6in. firebars.
All in good working condition. The first two items are still in use, but would be available to a purchaser within four weeks. The operating records of the boiler from which the stokers have been removed are available for inspection.
Offers must be made in writing to the Secretary, Clifton Hospital, York. E5171 G

NEW OVERHEAD CRANES

60-ton Goliath, by Clyde, 40ft. span, 5-ton auxiliary, cab control, 400/3/50.
40-ton Goliath, by Babcock and Wilcox, 40ft. span, 5-ton auxiliary; cab control, 400/3/50.
30-ton Adamson, 42ft. 3in. span, 5-ton aux.; new in cases.
20-ton Vaughan, 42ft. 3in. span, 6-ton aux., 17ft. lift, six available.
20-ton King, 42ft. 3in. span, unused.
10-ton Goliath, by Morris, 40ft. span, cab control, 22ft. lift, 400/3/50.
Surplus Unused Ministry Cranes, mainly still packed. Drawings on request. Inspection invited. Bargain prices.

FRED WATKINS (ENGINEERING),
LTD., COLEFORD, GLOS.
Tel.: Coleford 2271/2/3.

E132 G

FOR SALE, HEAVY STEEL OVERHEAD TRAVELLING CRANE GANTRY, capable of carrying two 130-ton overhead travellers; 182ft. long, height to crane rails 30ft., box section longitudinal girders 3ft. deep, 16 stanchions of lattice box construction. Total weight 150 tons. With or without two 130-ton Electric Hydraulic Overhead Travelling Cranes, 37ft. span.

REED BROTHERS (ENGINEERING), LTD.,

Replant Works,
Woolwich Industrial Estate,
London, S.E.18.
Telephone: Woolwich 7611/6.

E5139 G

MASSEY 2-CWT. SIZE PNEUMATIC POWER HAMMER for sale. Overhanging type with slides. Arranged motor drive 400/3/50. Complete with separate anvil. Longest stroke 14in. Weight about 55 cwt. Photo, &c. from F. J. EDWARDS, Ltd., 359, Euston Road, London, N.W.1, or 41, Water Street, Birmingham, 3.

E5174 G

FOR SALE

SERVICE EDWARDS VALUE!

New BESCO 8ft. 4in. by $\frac{5}{8}$in., Type HK., All-Steel Undercrank Open Ended Production Power Guillotine of all-steel construction, arranged motor drive for 400/440/3/50, length of blades 110$\frac{1}{2}$in., capacity $\frac{5}{8}$in., gap in side frames 3$\frac{1}{2}$in., strokes per minute 54.
INCANDESCENT Forced Draft Bar Heating Furnace, double-ended, gas fitted, heating chamber 36in. wide by 24in. deep by 9in. high, total length through furnace 32in. working, temperature range 900 deg. to 1350 deg. C., 1200 deg. C. can be reached in about 1$\frac{1}{2}$ hours after starting from cold.
QUICKWORK No. 321 Motorised Rotary Shearing Machine, with circle cutting attachment, arranged motor drive for 400/440/3/50, capacity 14 S.W.G. mild steel, depth of shear throat 30in., cuts circles from 6in. to 60in. dia. Weight approximately 18 cwt.
JOHN HANDS Double Sided Friction Screw Press, arranged motor drive, for 400/440/3/50, fitted with Broughton automatic press guard, pressure exerted approximately 60 tons, maximum stroke 18in., between uprights 37$\frac{1}{2}$in., tee-slotted bed 36in. by 46in.
BLISS No. 1 Double Sided, Double Action, Geared Toggle Drawing Press, arranged for belt drive, punch stroke 7in., blankholder stroke 4$\frac{1}{2}$in., between uprights 17in., size of bed 16in. by 18$\frac{1}{2}$in., hole in bed 6$\frac{1}{4}$in. diameter.
CRAIG & DONALD Model 400/10, All-Steel Motorised Double Geared Press Brake of steel plate construction, arranged motor drive for 440/3/50, pressure exerted approximately 400 tons, former capacity 10ft. by $\frac{1}{2}$in., width between side frames 82in., stroke approximately 4in.
BESCO High Duty Double Geared Guillotine Shearing Machine, Overcrank type, Model R., capacity 120in. by $\frac{1}{4}$in. mild steel, treadle operated clutch, motorised for 400/440/3/50.
Photographs of the above are available.
Very favourable Hire Purchase terms can be obtained.

MACHINE TOOLS, NEW AND USED,
Of Every Description. Attractive Prices.

F. J. EDWARDS LTD.,

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LONDON, N.W.1.
Telephone: EUSton 4681–3771.
and at
LANSDOWNE HOUSE, 41, WATER STREET,
BIRMINGHAM, 3.
Telephone: Central 7606–8. E207 G

FOR SALE, PRATT AND WHITNEY Model 1B Hor. Broaching and Rifling Machine. Brand New. Worth £5000. Price £800.
FAIRBAIRN Lawson Cylinder Liner Boring Machine, 14in. centre by 10ft. 6in. dia. boring.

NORMAN E. POTTS (B'HAM), LTD., 130, MOSELEY ROAD, BIRMINGHAM, 12.
E5147 G

FOR SALE, 1958 Chaseside 1 cu. yd. Loading Shovel, model 700. Perfect condition.
1950 Thomas and Foster 16 × 9 Toggle Motion Brick Crusher.

MAUDE BROS. (CONTRACTORS), LTD.,
263, WHITEHALL ROAD, LEEDS, 12.
Tel.: 637261. E2325 G

ALBRIGHT AND WILSON (MFG.), LIMITED, HAVE AVAILABLE FOR DISPOSAL the following new and unused spares for rotary calciners and coolers, but also suitable for other purposes:
4 Cast Steel Treads machined all over, 7in. by 3$\frac{1}{2}$in. section overall diameter 7ft.–8$\frac{1}{4}$in.
4 Cast Steel Tread Rollers, unmachined, 30in. diameter by 10$\frac{1}{4}$in. face.
12 5$\frac{1}{4}$in. diameter Cooper Split Roller Bearings.
2 Metallic Asbestos Sleeves, one 5ft. 10in. diameter and one 9ft. 6in. diameter.
The following unmachined shafts:
6 6$\frac{1}{2}$in. diameter by 2ft. 11in.
1 4$\frac{1}{2}$in. diameter by 2ft. 9$\frac{1}{4}$in.
Inspection can be made by arrangement with our Works, situated at The Docks, Portishead, Bristol (telephone number Portishead 3056).—Offers should be submitted in writing to the Central Buying Department, Oldbury, Nr. Birmingham (telephone number Broadwell 1595). E5167 G

FOR SALE

SECTION ROLLER FORMING MACHINES for sale. 6 and 8-stations, with separate curving units. Set up for making motor cycle rims, but will form all kinds of curved sections with the necessary rollers. Width between roller housings 19in. and 12in. Diameter of shafts 3in. Length of bed 14ft. Weight approximately 13 tons and 12 tons. Motor drive from 30 h.p. motor suitable for 400/440 volts, 3-phase, 50 cycles. Full details and photos, &c., from

F. J. EDWARDS LTD.,

359, Euston Road, London, N.W.1,
or
41, Water Street, Birmingham, 3.

E5173 G

FOR SALE

ONE 30ft. by 9ft. Lancashire Boiler by Adamson in 1939, suitable for steaming at 220 p.s.i., complete with Danks Chaingrate Stoker (new 1955) and all ancillary gear (new 1955).
ONE Economic Boiler by Danks in 1941, suitable for steaming at 120 p.s.i., complete with Bennis Stoker, feed pump, forced and induced draught fans with motors, &c.
ONE Water Softening Plant (Hot-type, Lime Soda) by Permutit, 1954, to handle 5500 g.p.h.
ONE Greens Economiser No. G.7213, 240 tubes, with 2 h.p./440 volt motor and all gear.
ONE Induced Draught Fan, complete with V-rope drive and 45 h.p. T.E.F.C. Motor by B.T.H. for 440 volt.
ONE Forced Draught Fan complete with V-rope drive and 25 h.p. T.E.F.C. Crompton Parkinson motor and starter for 440 volt.
ONE Weir Boiler Feed Pump 7in. by 9$\frac{1}{2}$in. by 21in. stroke.
ONE Weir Boiler Feed Pump 8in. by 10$\frac{1}{2}$in. by 22in. stroke.
ONE Kent type KM/CD Steam Meter, 0–50,000 lb. per hour.
ONE Kent 2-pin Temperature Recorder 200 deg.–1000 deg. Fah.
ONE Cambridge 2-pin Temperature Recorder 50.
ONE Budenberg Pressure Recorder, 8in. chart, 0–120 p.s.i.
FOUR sets BENNIS Stoker Gear for 30ft. by 9ft. Lancashire Boilers.
ONE Radiovisor Smoke Density Indicator for 200/250 volt supply.
All enquiries to Buying Dept.,

BROTHERTON AND COMPANY, LTD.,
P.O. Box No. 6, Leeds, 1.
Tele.: 29321.

E5165 G

FRED WATKINS (ENGINEERING), LTD.

STEAM BOILERS.—Cochrane Vertical (New), 8ft. 6in., 8ft., 7ft. 6in., 7ft. and 6ft. in dia., 100/150 lb. w.p.; reconditioned 8ft. 6in. down to 3ft. dia.; Economic 4ft. to 11ft. 6in. dia., including new 7ft. and 8ft. dia., 150, 180 and 200 lb. w.p.; 300 reconditioned Vertical Crosstube, all sizes.
AIR COMPRESSORS.—Two Belliss & Morcom 2500 c.f.m., 100 p.s.i., 550 h.p. motors; also Broomwade 500, 400, 300, 200 and 130 c.f.m., all motorised; and several others of various makes and capacities.
200 AIR RECEIVERS, stocked up to 9ft. dia., 100 to 500 lb. pressure.
ELECTRIC MOTORS.—150 Totally Enclosed and Flameproof Motors up to 100 h.p.
MOBILE ROAD CRANES.—10-ton Lorain lorry mounted, 30ft.–70ft. extendible jib; 10-ton 33 R.B. track mounted 40ft. jib; 8$\frac{1}{2}$-ton Ransomes Petrol/Electric, 21ft. jib; 6-ton Coles Diesel/Electric, pneumatics, new 1948 (2); 6-ton Coles Diesel/Electric solids; 4-ton Coles Diesel/Electric, solids, 1945; 4-ton Jones K.L44, diesel, 1950; 3-ton Jones "Super 40" diesel, pneumatics (3); 2-ton Jones "Super 20" diesel, pneumatics.
DERRICK CRANES.—10-ton Anderson Grice steam, 120ft. jib; 7-ton Rushworth, hand, 30ft. jib; 5-ton Wilson Electric, 70ft. jib; 1$\frac{1}{2}$-ton Anderson Grice, hand, 40ft. jib.
RAIL CRANES.—18-ton Brownhoist, steam, 50ft. jib; 10-ton Coles steam, 40ft. jib; 8-ton Wilson steam, 35ft. jib; 5-ton Smith, 50ft. jib (2); 5-ton Cowans Sheldon, 50ft. jib.
LOCOS.—Fowler diesel, 150 h.p. (2); Ruston diesel, 80/88 h.p., new 1942; Bagnall 14in. by 22in., two oil fired, one coal; Peckett steam, 7in. by 12in., 1941; also 3 miles track, 24in. gauge Bogies, Turnouts, &c.
STEEL PIPING.—50,000ft., 2in. Galvanised, new; 60,000ft., 3in. black, new; 5000ft. 8in. seamless; 1000ft., 12in. seamless; 500ft., 14in. seamless; 400ft., 18in. riveted; 280ft., 21in. o.d. welded flanged; 3800ft., 21in. seamless flanged; 500ft., 24in. riveted; 1450ft., 27in. o.d. welded flanged; 216ft., 48in. riveted; 216ft. 60in. riveted.
CAST IRON PIPES.—Large stocks all sizes up to 24in. flanged and s.s. Immediate delivery.
VALVES.—Exceptional Surplus Ministry Lot New Stainless Acid Cocks and Valves, over 5000, immediate delivery, below makers' prices. Large stock, all sizes, Parallel Slide Sluice, Gunmetal, Reducing and Check Valves. List on request.
STORAGE TANKS.—300 cylindrical and rectangular up to 12,000 gallons, for oil and petrol, also sectional steel and cast iron up to 50,000 gallons.
MACHINE TOOLS.—Scriven Plate Bending Rolls, 14ft. by $\frac{1}{4}$in.; Robertson Straightening Rolls, 8ft. 6in. by $\frac{1}{2}$in.; Berry Bending Rolls, 7ft. by $\frac{1}{4}$in.; Tangye 200-ton Hydraulic Vertical Straightening Press, 15ft. by 3ft. table; Herbert 3ND Miller, 61in. by 15in. table; Pels Punch and Shears, $\frac{3}{4}$in. capacity; nine new 2 cwt. and 1 cwt. Pneumatic Hammers; Bliss 14T Tapering Press; Bonn Hydraulic Tube Bender up to 20ft. by 4in. bore; Bigwood geared Bending and Straightening Machine up to 12in. by 6in. R.S. Joists; two 40kVA Spot Welding Machines; Wire Drawing Machine, 3 die up to $\frac{3}{8}$in. copper; 50kW Electric Furnace 1000 deg. Cent., chamber 54in. by 30in. by 21in.

SLING ENGINEERING WORKS
COLEFORD, GLOS.
'Phone: Coleford 2271/2. E106 G

FOR SALE

600

FOUR 400 h.p. ROLLING MILL DRIVES, by English Electric Co., for 440 volts, 3-phase, 50-cycles supply, each comprising slipring motor, 738 r.p.m., coupled to gearbox giving final 30 r.p.m., with barring motor, control gear, oil pumps, oil cooler; transformers available for 11,000/415 volts, with switchgear.
1000kW., 1250kVA., geared, back-pressure type STEAM TURBO-ALTERNATOR SET, incorporating turbine by W. H. Allen, designed to work with steam at 165 p.s.i., 463 deg. F. temperature, exhausting to back pressure up to 30 lb., direct coupled to alternator by Mather and Platt, 400/440 volts, 3-phase, 50 cycles, with switchboard.
675kW., 400 volts, 3-phase, 50 cycles, 4-wire, back-pressure type STEAM TURBO-ALTERNATOR SET, comprising turbine by Belliss and Morcom, 150/200 p.s.i. initially, exhausting against 10/15 lb. back pressure, direct coupled through David Brown gearbox to alternator by Brush Electrical Co., with switchgear.
500kW. geared, pass-out/condensing STEAM TURBO-ALTERNATOR SET, incorporating turbine by Belliss and Morcom, designed to work with steam at 190 p.s.i. and suitable for 200 p.s.i., passing out up to 10,000 lb. steam per hour at 60 lb. pressure, direct coupled through gearbox by the Power Plant Co., ratio 10 : 1 to alternator by the Electric Construction Co., 400/440 volts, 3-phase, 50 cycles, complete with switchgear.
500kW. continuous 24-hour rating, 400 volts, 3-phase, 50 cycles, 4-wire DIESEL-ENGINE-DRIVEN ALTERNATOR SET, direct coupled at 375 r.p.m., incorporating Belliss and Morcom 7-cylinder diesel engine, direct coupled to alternator by Lancashire Dynamo and Crypto, complete with starting equipment and standard accessories.

GEORGE COHEN,

SONS AND CO. LTD.
WOOD LANE, LONDON, W.12.
Tel.: Shepherds Bush 2070.

E201 G

FOR SALE

10-ton Morris 3-motor, Cab controlled Overhead Electric Travelling Crane, 45ft. span, Electrics 460/500V. d.c.
7$\frac{1}{2}$-ton Aabacas Ditto, 31ft. span, 400/3/50, new 1953.
5-ton Heywood Ditto, 36ft. 3in. span, 400/3/50, new 1950.
5-ton Anderson-Grice Ditto, 36ft. 3in. span, 400/3/50, new 1950.
5-ton Royce Ditto, 54ft. 3in. span, 220V, d.c., new 1936.
10-ton Morris Ditto, 62ft. 6in. span, Hand, new 1936.

F. BURRILL AND CO.,
235a, Cathedral Road, Cardiff.
Tel.: 26100. E5168 G

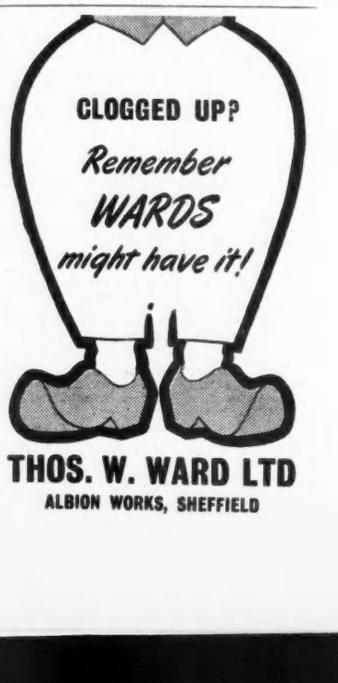
FOR SALE

RAILWAY TURNTABLE
For sale.—Mundt type standard gauge turntable, 65ft. long, carrying capacity 150 tons approx. Seen Chipping Sodbury.
WATER CRANE
3000 gallon water crane. Seen Chipping Sodbury.
TURNOUTS
Twenty 1 in 8 turnouts in 75 lb. F.B. rail; interchangeable to suit L.H. or R.H.
All these items are in excellent condition.

Apply: EAGRE CONSTRUCTION CO., LTD., East Common Lane, Scunthorpe, Lincs. ('Phone: 4513.) E5100 G

NISSEN TYPE HUTS for sale. Prompt despatch of 16ft., 24ft. and 30ft. wide huts; also "Romney" Huts, 35ft. wide, and "Blister" Hangars, 86ft. 6in. and 91ft. wide. These buildings are in various lengths and comprise steel framework with galvanised corrugated steel sheeting.—Full details from Dept. 115, J. Thorn and Sons, Ltd., Brampton Road, Bexleyheath, Kent (Tel.: Bexleyheath 305). E113 G

FOR SALE Horizontal Double-ended Batch type Furnaces with forced air circulation by Birlec for temperature range 0 deg. to 400 deg. Cent., furnace size 17ft. 6in. length by 5ft. 10in. width by 3ft. height, complete with roller tracks and all electrical accessories for 400V, 3-phase, 50 cycles.—R. S. HAYES, LTD., Bridgend, Glamorgan. Tel. No. 1311 (3 lines). F5097 G



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E R

By Order of the Secretary of State for Air.
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HARTLEBURY, Worcestershire.
(4 miles from Kidderminster, 11 miles from Worcester)

Nock & Joseland

are instructed to Sell by Auction at the above Unit on
THURSDAY, 19th MARCH, 1959,
at 11 a.m. prompt,
A Large Quantity of Valuable

MISCELLANEOUS STORES

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CLOTHING AND EQUIPMENT,
FOOTWEAR AND CORDAGE,
CAMERAS AND PHOTOGRAPHIC EQUIPMENT,
OFFICE FURNITURE,
RADIO AND ELECTRICAL EQUIPMENT,
GENERAL STORES.
VIEWING :—
The Lots are on View at Hartlebury on Wednesday, 18th March, 1959, between the hours of 9 a.m. and 4 p.m., and on the morning of the Sale Day between the hours of 8 a.m. and 11 a.m.
Admission only on production of catalogue, which will admit two persons on the View Day and one person on the Sale Day. The Secretary of State for Air reserves the right to refuse admission. Catalogues, price ONE SHILLING EACH (Postal Orders, NOT Stamps) can be obtained from the Auctioneers :
Nock and Joseland, Bank Buildings, Kidderminster (Tel.: 2053 and 4211). E9970 J

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HYDRAULIC PRESSES
HYDRAULIC PUMPS

Hydraulic Accumulators, Valves, Fittings. New and Second-hand. Complete installations.
All kinds of Hydraulic Equipment in Stock.
THOMPSON AND SON (MILLWALL), LTD.,
Cuba Street, Millwall, London, E.14.
East 1844/5. E111 G

FOR SALE

Seven Murex diesel Welding Sets, 300/400 amp.
Quantity of Guyrex and RMD Shuttering.
Three-tool BroomWade 167 cu. ft. Portable diesel Compressor Set on pneumatics with overrun brakes.
1 cu. yd. Rapier 440 diesel driven Excavator with shovel or dralgine equipment.
¾ cu. yd. Rapier 410 diesel-driven Excavator with 4-purpose or dragline equipment.
⅜ cu. yd. Rapier 423 diesel-driven Excavator with shovel equipment.
5-ton Morris Versatile diesel/elec. Mobile Crane on solid rubber tyres.
5-ton Smith Steam Loco. Crane, 4ft. 8½in. gauge, 35ft. jib, new 1949.
6-ton Rapier Super pet./elec. Mobile Crane on solid rubber tyres.
6-ton Rapier Standard pet./elec. Mobile Crane on solid rubber tyres.
4½ cu. yd. Aveling-Barford diesel-driven Dumper.

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E5127 G

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FOR SALE

HEAVY DUTY PLATE FLATTENING AND DE-COILING ROLLS

Manufacturers, Postle Brothers of Scotland. Capacity ¼in. plate by 7ft. max. width. Motorised 400/3/50 cycles. Specification : These rolls comprise 4 up and 3 down 10in. diameter rolls, independent hand control to leading and trailing rolls ; central rolls controlled by separate control wheel ; hand adjustment. The drive is by a 30 h.p. Verity's a.c. motor, 400V, 3-phase, 50 cycles at 950 r.p.m. The unit is provided with an Ellison oil-immersed starter type E and the rolls are controlled by a tram type control unit giving instantaneous forward and reverse without stopping the motor. Speed of rolling 12½ft. per minute at full speed, but slow speed by tram controller if required. From the motor to the rolls are double helical cut gear train to main roll drive and reducing gear cogs to each of the bottom rolls. From this you will see that all three bottom rolls are powered. The machine has the advantage that it can be used for de-coiling plate when supplied in coil form in the thickness range of ⅛in. to ½in. We ourselves have used this machine for de-coiling Steel Company of Wales coils up to 6 tons in weight and ¼in. thick by 6ft. wide. The machine, being of a heavy duty nature, is capable of pulling this class of plate into the rolls by its own power and subsequently de-coiling and flattening at the same time. The machine, which is of rugged construction, is mounted on a common bed-plate on broad flange beams and has been thoroughly overhauled by Messrs. T. C. Neville, millwrights and engineers, of Walsall, when repairs amounting to £300 were carried out. These rolls are offered with every confidence and can be inspected in running order at these works.
Price, loaded to transport—£2850.
CHURCH AND BRAMHALL (STOCKHOLDERS), LTD.,
Reservoir Place, Pleck, Walsall.
Telephone : Walsall 5164. E5126 G

METROPOLITAN-VICKERS 500 H.P. SLIP-RING ELECTRIC MOTOR, 196 r.p.m., 400/440/3/50 cycles, complete with control panel and reduction gearbox, giving a final speed of 8·1 r.p.m.
Motor and gearbox available separately if required.

JOHN CASHMORE, LTD.
Newport, Mon.
Tel.: Newport 66941 (6 lines). E120 G

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E R

By Order of the Minister of Supply

GOVERNMENT SURPLUS STORES

SALES BY AUCTION

		Main Location	*Auctioneers*
March 17	**Machine tools, plant and miscellaneous stores.**	M.O.S. Storage Depot, **Harrogate Road, Yeadon, Leeds.**	**DACRE, SON & HARTLEY** (Dept. L), Station Road, Otley, Yorks. (Tel.: 3321.)
March 20	**Miscellaneous stores,** including:—	Command Ordnance Depot, **Coypool, Marsh Mills, Plymouth.** (Sale at Kinterbury House.)	**WOOLLAND, SON & MANICO** (Dept. L), Kinterbury House, St. Andrews Cross, Plymouth. (Tel.: 65356.)
	textiles, greatcoats, denim trousers and blouses, tool kits, ferrous and non-ferrous scrap, engineering stores. Contents of hostel, including beds, sheets, blankets, chairs, tables, kitchen equipment, etc.		
March 25–26	**Machine tools and miscellaneous stores,** including:—	Technical Stores Depot, **Old Dalby, Leics.** (Sale at Melton Mowbray.)	**SHOULER & SON** (Dept. L), 1, Norman Street, Melton Mowbray, Leics. (Tel.: 3081.)
	lathes, pillar and portable drills, machine tool spares, welders and welding kits, diesel generating sets, charging sets, air compressors, matrix metal ingots and other non-ferrous metals, photographic equipment, test instruments, 10,000 gravity conveyor rollers, 150 tons steel scaffolding, racking, warehouse pallets, trailer fire pumps, waterproof sheets, large quantity of dubbin, dial and platform scales, baling presses, barrows, trucks, cranes, timber beams and skids, hessian cloth, hand tools, office furniture, fire hose, buckets, etc.		
April 6–10	**Vehicles, lifting and earth-moving equipment, motor cycles,** etc.	M.O.S. Storage Depot, **Ruddington, Notts.**	**WALKER, WALTON & HANSON** (Dept. L), Byard Lane, Bridlesmith Gate, Nottingham. (Tel.: 54272.)
April 8	**Miscellaneous stores,** including textiles, furniture, etc.	Command Ordnance Depot, **Hilsea, Portsmouth, Hants.**	**HALL, PAIN & FOSTER** (Dept. L), 54–60, Commercial Road, Portsmouth. (Tel.: 24421/4.)
April 14	**Vehicles, motor cycles and miscellaneous stores.**	Central Ordnance Depot, **Bicester, Oxon.**	**MIDLAND MARTS, LTD.** (Dept. L), Market Square, Bicester, Oxon. (Tel.: 73.)
April 21–22	**Miscellaneous stores.**	M.O.S. Storage Depot, **Byley, Nr. Middlewich, Cheshire.** (Sale at New Islington Public Hall, Ancoats, Manchester.)	**J. H. NORRIS & SON** (Dept. L), 9, Albert Square, Manchester, 2. (Tel.: Blackfriars 8373.)

Applications for catalogues should be made *only* to the auctioneers shown above (price of catalogue 1s. 0d., P.O. only).

SALE OF BOOTS BY TENDER

The Minister of Supply announces the disposal of approximately 658,000 pairs of ARMY ANKLE BOOTS. These will be sold by tender FOR EXPORT ONLY in lots of approximately 10,000 pairs.
The sizes range from 2 to 13 with the bulk lying in the size ranges 7 to 9.
Applications for forms of tender should be sent to the Ministry of Supply, Director of Disposals D. 4(c), Room 615, First Avenue House, High Holborn, London, W.C.1. Full conditions of contract, including undertaking to export, are contained in the document.
Completed tenders to be submitted by 20th April, 1959.
E118 J

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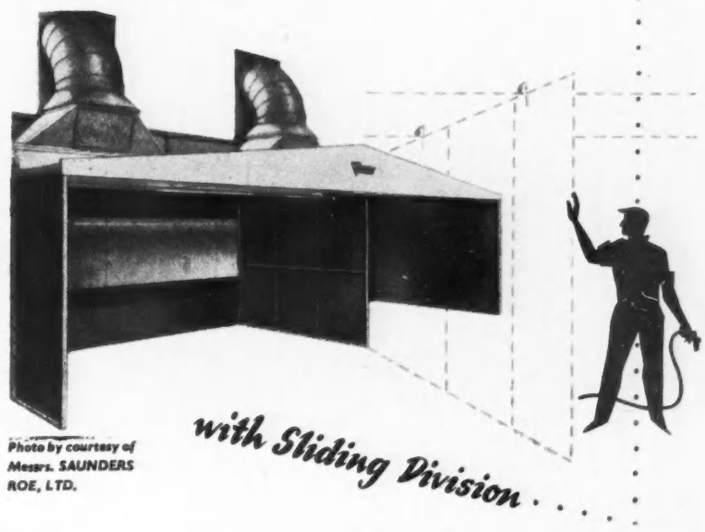

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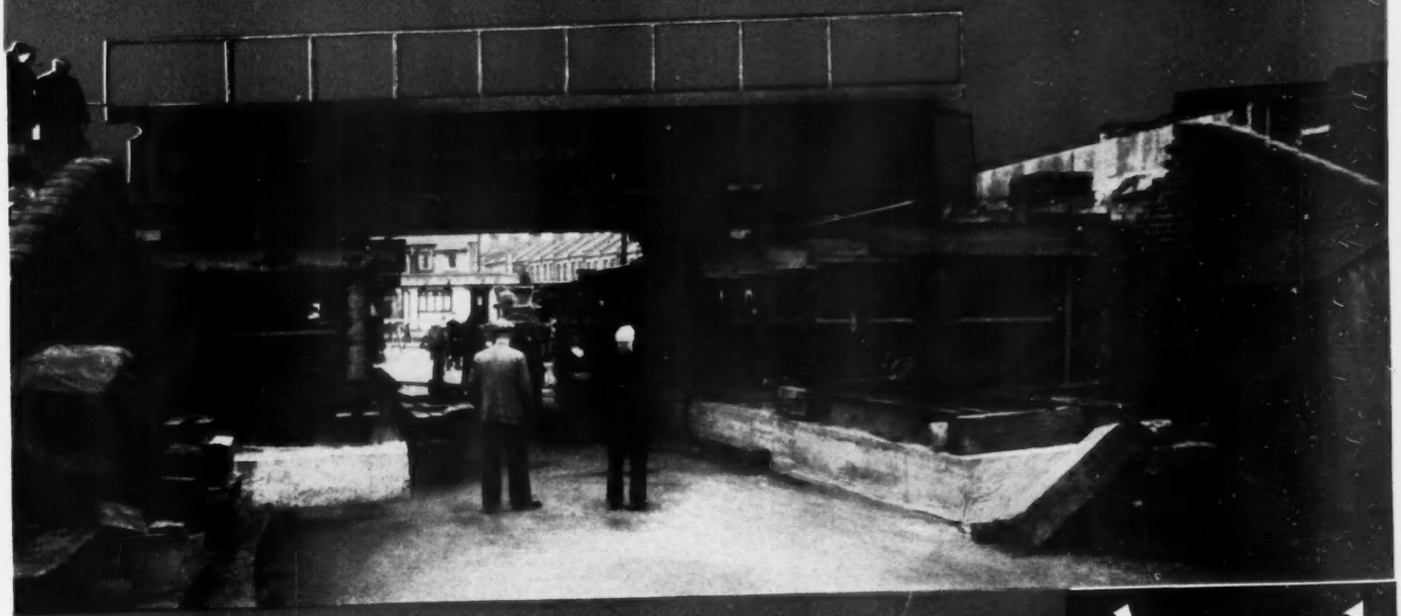
Bridge 1807, Barnet Road, between Seven Sisters and Bruce Grove shown being rolled into position.



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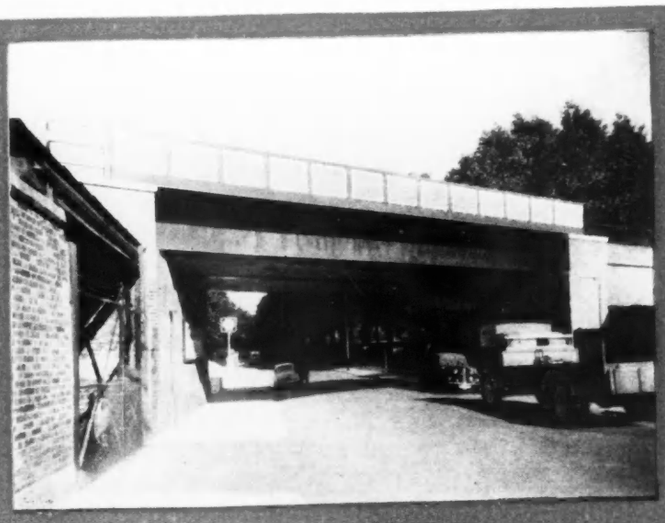

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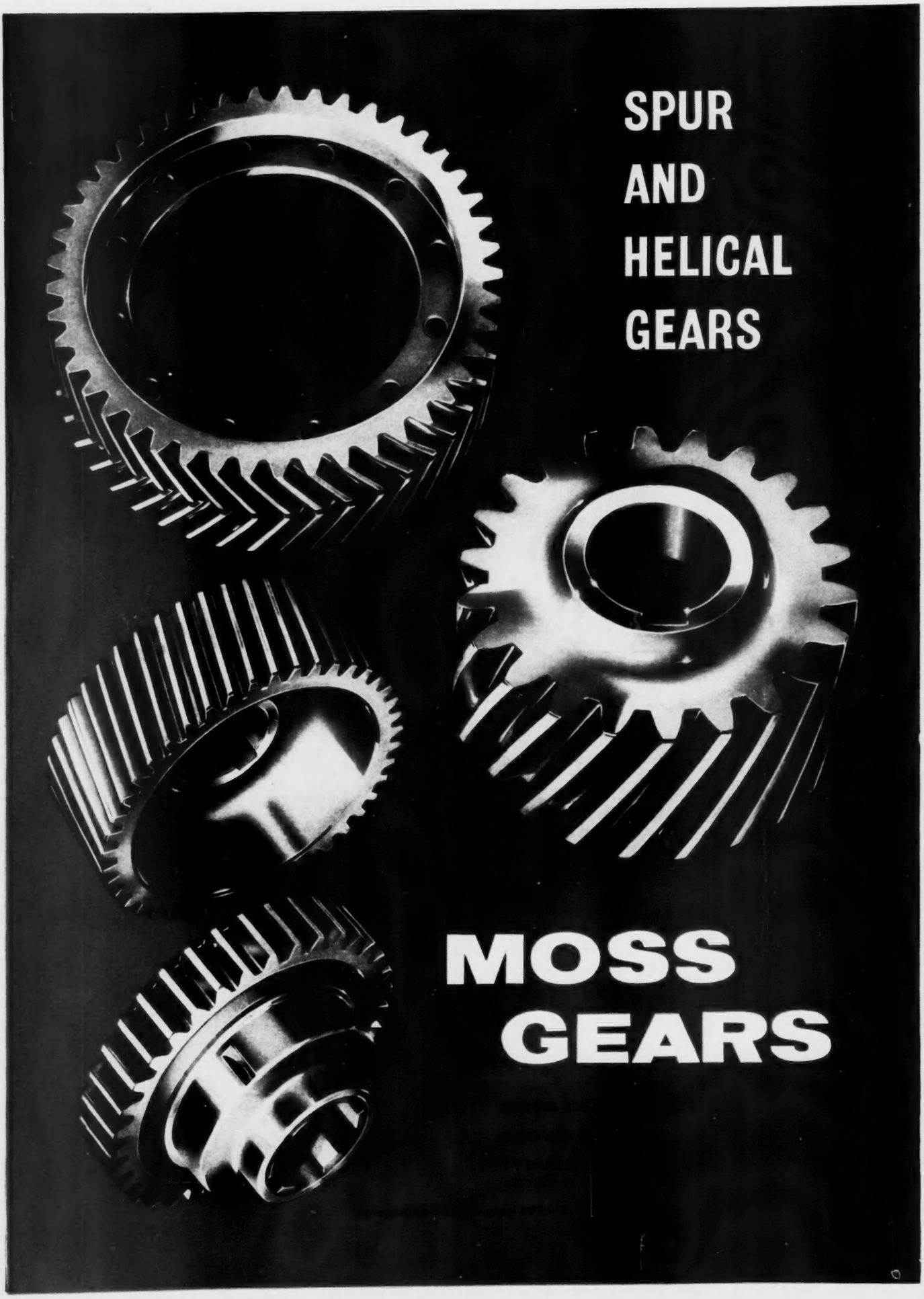
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